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ART. XIII.—*Notice of the Pitch Lake of Trinidad;* by Mr. N. S. MANROSS.

THIS remarkable curiosity is situated on the western shore of the Island about midway from its northern to its southern extremity. A range of mountains twelve hundred feet high crosses the upper end of Trinidad, forming a continuation of a still higher range upon the main land. Through this chain the sea has broken the narrow passage called the Dragon's Mouth, by which the strong current which sets in at the southern extremity of the gulf of Paria, and is there augmented by the waters of the Orinoco, finds passage into the Caribbean Sea. So narrow is this opening that it can only be perceived when the voyager is directly in front of it. From all other points of view the Island appears like a peninsula still joined to the continent by an unbroken chain of mountains. The sea is still unsatisfied with its narrow outlet and is constantly undermining the vast isolated masses of rock which stand like teeth in the Dragon's Mouth.

The freshly broken precipices give evidence of recent falls which indeed have been sometimes heard at Port au Spain ten miles distant.

These mountains consist mainly of highly inclined and contorted strata of talcose and micaceous slates containing veins of somewhat crystalline quartz. The flanks and spurs of the range however exhibit a dark blue limestone, much veined with white, in which there are caves of considerable extent. These so far as

I could ascertain, are the only ancient rocks, as they are the only mountains in the island.

On the south the mountains sink abruptly down nearly to the level of the sea, leaving the remainder of the island an almost unbroken plain of tertiary clay, sandstone and marls.

From the city of Trinidad or Port au Spain, which stands between the base of the hills and the sea, to the Pitch Lake 39 miles south, only a single hill, some two hundred feet high, breaks the uniform, and for the most part, densely wooded surface.

A fine steamer plies up and down the gulf of Paria, touching twice a week at the village of La Braye in front of the Pitch Lake. As we approach the village a long black line between the white foam of the waves and the dark green of the dense vegetation indicates something unusual in the nature of the shore. A small boat bears the passenger through a considerable surf and lands him on rough jagged rocks of hardened, but where the sun touches them, still flowing pitch.

The village of La Braye stands on a projecting tongue of land which owes its preservation from the inroads of the sea to the fact that it consists entirely of hardened pitch, which withstands the waves far better than the loose materials of the accompanying formations. The shore for miles both north and south consists mainly of the same material and juts out boldly into the sea wherever it is thus pitch-bound.

The village itself is built upon pitch. The inhabitants complain that their dwellings are liable to be thrown out of level by the rising or sinking of the tarry foundations.

Gardens and fruit trees flourish in the few inches of soil which cover the bitumen.

A road leads up from the landing to some sugar estates beyond the lake. It ascends a gentle slope of hardened pitch which where left to itself is covered with a dense growth of reeds and bushes, but where broken up by cultivation produces abundantly the usual tropical garden fruits.

In some places the bitumen is so mixed with earth as to lose some of its toughness as well as some shades of its pitchy hue.

Just above the village, in a small clearing, some twenty graves are marked by black crosses and still blacker mounds. They are excavated in the same sombre-tinted material. It would be interesting to know whether the bituminous matter has exerted any of its well known preservative powers upon the bodies thus entombed in it; but I could not learn that either accident or design had ever invaded any one of these strange sepulchres.

The road itself is a fine illustration of the adaptation of the pitch to the purposes of paving. Where too much mixed with earth it has become pulverized to the depth of a few inches. But in many places it is still so pure and solid that the wheels of heavily loaded sugar wagons and the hoofs of horses make but a slight and even that a transient impression.

In no part of the ascent from the shore of the lake does the stream of pitch appear to be covered by more than one or two feet of soil while in most places it is entirely bare. Its hardness is about that of gypsum. It breaks with a conchoidal but lusterless fracture. In places where the surface is not protected by vegetation it becomes so far softened by the sun as to be still making progress downward.

On nearing the lake the ascent becomes steeper, amounting to perhaps twenty-five feet in the last ten rods. Here the pitch is bare or but slightly covered with grass. Its appearance is not that of a sudden simultaneous overflow in a single smooth stream, but that of a great number of streams each but a few yards or rods in breadth.

These independent streams have jostled one another strangely in their progress. Their surfaces are wrinkled and drawn out into all manner of contortions, and where the edges meet, small ridges have been thrown up and the pitch broken into fragments not unlike the scoriæ of lava currents. These fragments of pitch were on fire in several places, having been kindled by a fire which ran through the "bush" a few weeks before. It is fortunate that the pitch when compact will not kindle, or in other words will not burn without a wick, for otherwise the entire region including the village of La Braye might suffer the fate of Sodom and Gomorrah.

The distance from the landing to the lake is three-fourths of a mile, the rise ninety-six feet.

The direction of the principal stream from the lake is due north.

On ascending the last slope of this pitchy glacier a singular scene meets the eye. A black and circular plain of pitch half a mile in diameter lies flush with the edge of the stream. It is surrounded by a dense wall of forest in which various species of tall palms are most conspicuous.

The lake itself is entirely bare of vegetation, except about twenty small clumps of trees which are arranged in a sort of broken circle about half way from the center to the circumference.

On a closer inspection the entire surface of this circular plain is seen to be intersected by a network of water channels Its appearance is exactly that of marbled paper. The pitch is divided into flat or slightly convex areas mostly polygonal but sometimes circular. They vary from one to eight rods in diameter. The intervening spaces are full of water. At the time of my visit, which was in the month of May and just at the close of the dry season, the water was so far reduced that it was easy to pass over all parts of the lake by leaping the channels. At other seasons this is more difficult.

These channels have heretofore been described as crevices or cracks in the pitch. This description is however incorrect for the material though apparently almost as hard as stone is yet far too plastic to admit of any thing like a fissure remaining open in it. Excavations from which many tons of pitch have been taken for exportation are closed up again in the course of a few days or weeks, not by streams of pitch flowing into them but by the gradual closing in of the sides and bottom.

The channels are produced and maintained by the following singular process. Each of the many hundred areas into which the lake is divided possesses an independent revolving motion in this wise. In the center of the area the pitch is constantly rising up —not breaking out in streams, but rising *en masse.* It is thus constantly displacing that which previously occupied the center and forcing it towards the circumference.

The surface becomes covered with concentric wrinkles, and the interior structure somewhat laminated, while the upper laminæ at the center of the area are torn into shreds by the expansion like the outer bark of a rapidly growing tree.

Where the edge of such an expanding area meets that of the adjoining one the pitch rolls under to be thrown up again in the center at some future period. The material is rarely soft enough to meet and form a close joint at the top but descends with a rounded edge and at a considerable angle.

The spaces thus left between the different areas are often five or six feet deep and three or four yards wide at the top, diminishing of course to a mere seam at the bottom.

Where three or more of them meet a star shaped cavity is formed in some cases twelve or fourteen feet deep.

It is difficult to conceive of a motion like this going on in a material almost of stony hardness, but that such a revolution is constantly taking place over the entire surface of this lake cannot be doubted.

Another curious proof of it is afforded by numerous pieces of wood which being involved in the pitch are constantly coming to the surface. They are often several feet in length and five or six inches in diameter. On reaching the surface they generally assume an upright position, one end being detained in the pitch while the other is elevated by the lifting of the middle. They may be seen at frequent intervals all over the lake standing up to the height of two or even three feet. They look like stumps of trees, protruding through the pitch, but their parvenu character is curiously betrayed by a ragged cap of pitch which invariably covers the top and hangs down like hounds ears on either side.

The conclusion then to which a close observation leads us in regard to the present condition of this singular lake is, not that it has suddenly cooled down from a boiling state as heretofore de-

scribed, but that, solid as the material is, it is still boiling although with an indefinitely slow motion. As the descent of the glaciers may be considered the slowest instance of flowing in nature so the revolutions of the scarcely less solid bitumen of this lake may be set down as the slowest example of ebullition.

The water which fills the crevices of the pitch is clear and very pure, especially towards the margin of the lake. It is the favorite resort of all the washerwomen for miles around.

So completely does the lake occupy the summit of the peninsula on which it is situated that water was observed flowing from the connected network level at eight nearly equidistant points of the circumference.

As the water is flowing now the pitch has formerly flowed from the lake in nearly all directions. It covers almost the whole peninsula like a mantle, reaching down to the sea and forming almost three miles of coast. The entire surface covered by it is estimated at three thousand acres. The lake itself contains one hundred acres. At the village of La Braye the stream of pitch has been dug through in several places, averaging from fifteen to eighteen feet in depth. Its depth at other places is not known.

Towards the center of the lake several detached areas are met with which are still quite soft. These have a glossy black surface. None of them are more than two or three rods in breadth. Those adjoining are rough and hard though not as hard as those nearer the margin.

The surface of these softer areas yields under the feet. On standing a few minutes one feels that he is gradually settling down, and in the course of ten or fifteen minutes he may find himself ancle deep.

In a few places indeed where streams of fluid pitch were oozing through the more indurated surface, a few minutes standing would sink one to the knees.

The pores of the pitch are full of water which oozes out on the slightest pressure, and by moistening the skin prevents adhesion. Were it not for this the above experiment would not be altogether so safe or agreeable.

A heavy body placed on the pitch or a person standing long enough, would undoubtedly sink and perhaps disappear in it. But in no place was it possible to form those bowl-like depressions around the observer as described by former travellers. It may be that the material has become much harder since the first accounts of it were written: but it is difficult to understand how the weight of a man could ever have displaced a mass of pitch equal to a "great bowl" as deep as the shoulders, especially as the pitch is specifically much heavier than the human body.

The water in the vicinity of the soft pitch is colored dark green by carbonaceous matter. It has also a saltish taste and a disagreeable odor. A strong smell of bitumen is perceivable in the air.

Streams of gas issue from below, sometimes rising through the water but more frequently hissing and gurgling from small openings in the pitch above water level. It appears to be chiefly sulphuretted hydrogen, smelling strongly of that gas and instantly blackening a silver coin laid among the bubbles. When inflamed it burns with a pale yellowish flame.

The surface of the pitch is whitened in places by a deposit of sulphur.

The temperature of one of the streams of gas was 97° Fah., the highest heat which I observed upon the lake.

The water in some of the crevices was 95°. In such cases it appeared to be rising at one end of the opening, flowing along, and descending at the other.

I have no doubt that the mere surface of the pitch is sometimes heated by the sun to a higher degree than this. But the copious streams of gas would certainly indicate the fact if a much higher heat existed at a moderate depth below.

The pitch where most fluid had a temperature of only 95°.

It is evident that the bitumen does not owe its fluidity in any great degree to heat. It is true that the already hardened pitch may be melted by a sufficient heat, but that which is already fluid remains so at all ordinary temperatures.

Wherever it oozes out in streams it flows down over the hardened surface into the nearest channel of water (which may have a temperature not above 85°), where it creeps along the bottom in a stream that looks like a huge serpent.

The fluidity of the pitch is evidently owing to the oily matter which it contains. The whole thing seems more like a vast fountain of coal tar than anything else. The gradual hardening which has evidently taken place is due to oxydation and evaporation of the less fixed ingredients,—a process which the revolving motion heretofore described must greatly facilitate.

In one of the star shaped pools of water, some five feet deep, a column of pitch had been forced perpendicularly up from the bottom. On reaching the surface of the water it had expanded into a sort of center table about four feet in diameter but without touching the sides of the pool. The stem was about a foot in diameter. I leaped out upon this table and found that it not only sustained my weight but the elasticity of the stem enabled me to rock it from side to side. Pieces torn from the edge of this table sank readily showing that it had been raised by pressure and not by its buoyancy.

The vicinity of the pitch with its strong odor seems to give no more offense to animals than its presence in the soil does to vegetation. Numerous fishes ten or twelve inches long were seen in the water on the lake. An alligator shuffled off from one of the areas at my approach. In two instances I scared birds resembling

night hawks from their nests or rather from their eggs which were deposited upon the naked pitch.

In the course of several days spent in examining the lake and the region around it I walked several miles along the sea-shore both to the northward and to the southward of the lake. To the southward the shore is made up of bold cliffs upon which the sea is making rapid inroads. The strata consist of indurated clays of brilliant red and yellow colors. They present also thick veins of porcelain jasper.

Strata of loosely coherent sandstones also abound. These are more solid and durable where they are impregnated with bitumen which acts as a cement. Rounded pebbles of pitch and porcelain jasper form a beach at the foot of the cliffs.

About a mile and a half south of the lake I observed numerous beds of slightly indurated clay filled with the remains of leaves and vegetation. A little further on appears a bed of brown coal and lignite about twelve feet thick. It has such a dip and direction that if continuous it would pass under the lake at a great depth. But the strata are here much contorted and some even thrown into upright positions.

Pebbles of pure asphaltum are thrown up by the waves at this point and not far off the beach is blackened by brilliant titanic iron sand.

Nearer the lake and to the southwest of it, a large spring of petroleum breaks out under the sea. The escape of gases from this vent is sometimes so violent as to spout a column of water several feet high.

I passed over the place in a boat but at the time there was no ebullition although a strong odor of bitumen pervaded the sea breeze and acres of the sea were iridescent with the floating oil. The rocks on the beach opposite were varnished of a bright glossy black by the petroleum. I filled a bottle with it by skimming it up from the water with a palm leaf.

Many springs of petroleum occur in the interior, within a few miles of the lake. Two veins of pure asphaltum enclosed in clay were discovered about three-fourths of a mile from the same place. They were soon however exhausted, having yielded some twenty tons of the mineral sufficiently pure for varnishes.

From the point where the large spring of petroleum breaks out under the sea, at least three miles of the shore to the northward consists mainly of streams of pitch from the lake. There are a few intervals of sandstone and clays where elevations have diverted the bituminous currents. But all the most prominent head-lands are those which are defended by the indurated pitch. This material has in fact flowed out to a considerable, though as yet unknown, distance under the sea.

About a mile to the northward of the lake another bed of brown coal crops out upon the shore. It is about twenty feet

thick. Other and perhaps much thicker beds may exist in the vast mass of stratified materials which make up the bulk of the island.

From the occurrence of such considerable accumulations of vegetable matter so situated as apparently to pass under the lake, it seems reasonable to regard them as the source of the pitchy matter which rises in such quantity there.

Indeed many pieces of wood may be observed in the beds of brown coal which differ in no respect in their appearance from many of the pieces thrown up in the lake itself.

These beds of vegetable matter are probably undergoing a slow distillation by volcanic heat. It is true there are no evidences of volcanic eruptions in the vicinity of the lake nor any materials of volcanic origin scattered on the beach except perhaps the titaniferous iron sand. But at Cedras, twenty miles to the southward, there are active mud volcanoes. I did not have opportunity to examine them or to ascertain their character minutely. But the fact of their existence as well as the disturbed condition of the recent strata, together with the proximity of the island to the coast of Cumana where earthquakes are frequent and severe, appears sufficient to show that the island is not entirely free from volcanic action.

Various attempts have been made to apply the inexhaustible store of bitumen afforded by the lake, to some useful purpose. Mixed with sand and pebbles it is much used for pavements and the ground floors of houses at Port au Spain, a purpose for which it is admirably adapted.

It has been employed to advantage as fuel by the American steamers plying on the Orinoco. It is thrown in the furnaces among the wood, fusing too readily to be used alone.

With ten per cent of rosin oil it forms an excellent pitch for vessels.

The Earl of Dundonald has purchased a large tract of the pitch lands including twenty six acres of the lake and has instituted various experiments with the view of substituting the bitumen for India rubber and Gutta percha in the manufacture of water proof fabrics, covering of telegraph wires, &c. Judging from the specimens of water proof cloth, tubing and telegraph wire which were shown me by his agent at Port au Spain, (Mr. C. F. Stollmeyer,) these efforts bid fair to be quite successful.

It seems only necessary that the required amount of intelligent enterprise should be directed to the subject in order to render this wonderful reservoir of bitumen a source of great individual profit and of essential service to mankind.

Art. XIV.—*The Harrison Tornado, Ohio, February* 14, 1854.

It is of interest in illustration of the subject of storms, to notice briefly the Harrison tornado, as its action differs in some respects from the Brandon storm. Many of its operations were chronicled as being of such a wonderful and unheard of character, that the writer was induced to visit the scenes of its ravages, to examine and record the facts, of whatever nature they might be.

During no season since, perhaps, the settlement of the state, have so many visitations of the kind occurred; and the opportunity afforded has been uncommonly favorable for investigating the phenomena of these storms.

The tornado under consideration, commenced, as far as can be learned, in Dearborn Co., Ia., 10 or 12 miles west of Harrison, in North Latitude 39° 10′ and West Longitude 70°. Its course was N. 72° 32′ E., ravaging the country, at intervals for 50 miles.

Its most marked characteristic was a diffuse and feeble action at the circumference, and intense energy at the axis. Occasionally it struck objects along its axis with the spite of a fury; closely approximating in its sudden and destructive effects, to the blast from a huge cannon. The most striking examples of its violence were found at the Graham place.

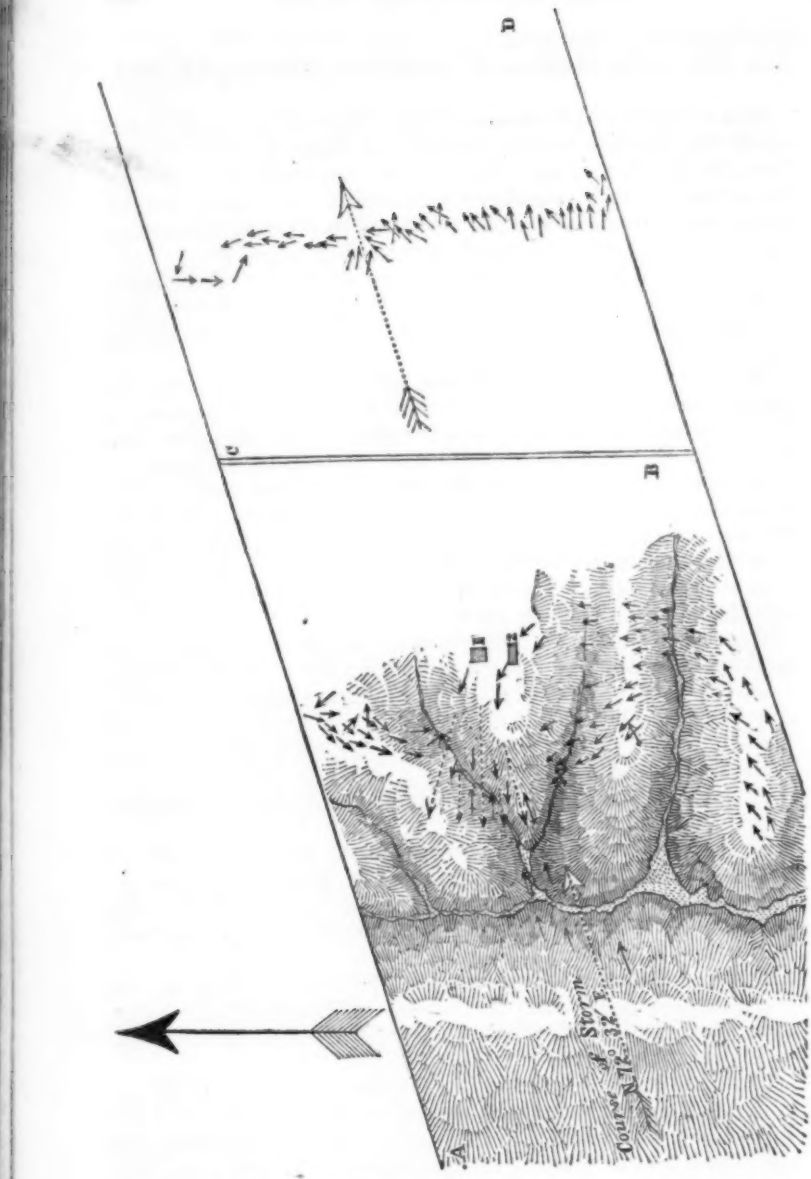
West of Harrison the country was very much broken; and generally wherever the tornado ascended a hill or crossed its top, it left the forest untouched; but the moment it began its descent, everything fell before it. It frequently rose from the earth, or was so broken up by the obstacles encountered, that extensive tracts were passed without injury.

Its destructive effects were mainly confined to a path varying from 200 to 600 feet in breadth.

At the Graham place it was three-fourths of a mile broad; at Mr. Wakefield's woods 66 rods; and at Dr. Bowles, from the extreme point on the right, where fences in the open fields were prostrated, to the left where trees were thrown down, must have been a little more than half a mile.

Careful observations were made at the Graham place, by the writer assisted by the Rev. M. Golliday of Harrison; also at the latter place; and at Mr. Wakefields; and a somewhat hasty examination at Dr. Bowles.

The Graham house (I) stood in the edge of a forest which extended to the west, with open ground on the east. West of the house (see plot) about $\frac{1}{4}$th of a mile, a narrow and deep valley runs north and south. Lateral valleys intersect this nearly at right angles from the east. These are also deep and narrow gorges, extending about one-fourth of a mile back from the main valley, forming sharp and well defined ridges between them. At the



A B, Topography of the Graham place, and plot of the tornado: Breadth ¾ mile.
C D, Plot of survey across Wakefield's woods: Breadth 66 rods.

head of one of these valleys and just where the descent into it begins, stood a small frame house. The action of the wind upon the house and the forest around, was extremely complex; and while passing across the track with a compass, the whole effect seemed like a riddle designed to puzzle meteorologists. On this account the survey was minute and protracted. The path was divided into sections of three rods each. The plot gives but a very small part of the bearings which were taken; in some cases a single arrow on the plot represents the mean of from three to ten bearings. The topography of the place is also represented as the complex action referred to, is believed to have been owing to the nature of the surface. The arrows give the directions of the currents which simultaneously or in succession swept over this ill-fated place.

The storm approached the house nearly from the west; and yet it was struck on the eastern side, by the current from the south-east. The proof of this is explicit. The whirling mass of vapor, attended with a thundering roar, was seen by Mr. Graham approaching from the west: he shut the door, a few moments of awful suspense followed: then a window over the east door was driven in with a loud report; then the door followed; and the next instant the house was torn from its foundations and shivered to fragments.

The tenants bruised and bleeding, and with tattered garments, were found in different positions.

The dotted arrows indicate the directions in which the fragments were carried. They were strewed over the ground for about 30 rods west of the house, and lay between N. W. and W. 6° S. A part of the roof was carried W. 6° S.; the chimney thrown W. 11° N.; a piece of a stove was picked up 30 rods N. W. Along these same bearings were portions of chairs, tables, bedsteads, boxes, boards, timbers, &c. It is a singular fact and shows the violence of the wind, that scarcely an article or a timber could be found in an entire state.

The barn (2) which was built of logs, fell to the N. W.; several trees near it in the same direction.

West of the house large trees lay between W. and W. 30° N. The bearings and positions of these are shown by arrows. Mingled with these are arrows with cross bars pointing easterly. These represent trees with their limbs lying above the other trees which had been thrown towards the west; and in a few instances fragments of the house were found beneath them.

This proves that the wind which first swept over the house was from the east, and afterwards it came with equal violence from the west. The latter action; that from the west, was doubtless caused by the passage of the axis of the storm.

One remarkable feature of the storm at this point, which will strike the meteorologist upon a bare inspection of the plot, is, that the current which destroyed the house should have been so far in advance of the axis as to carry fragments 30 rods to the west, before it curved into and mingled with the axis.

A second feature is that such unparalleled violence in the overthrow of the house, should have been exhibited by the outskirts of the storm. When the house fell, the axis could not have been less than 40 rods from it. Usually in narrow tornados, a point 40 rods from the axis is out of the range of violence.

What effect the contour of the ground may have had in producing these results, I leave meteorologists to judge. The portion of the tornado which struck the house, can be easily traced up the valley, which lies near the right hand border of the storms path. It passed up the valley and when near the head, plunged down the slope, and bridging over the bottom with fallen trees, ascended the opposite side, and gradually curved round into the axis. Portions of the house which were first swept around westward into the axis, were subsequently carried by it towards the east. A tea spoon was found E. 30° S. from the house, half a mile distant. A part of an eve-trough near the same place.

A piece of a chest easily identified, was carried N. E. two miles, and fell a mile north of the track of the storm. If the tornado had the form of an inverted cone, like the miniature whirls so often seen, then the transportation of this stick upwards and outwards is easily explained. Other explanations might indeed be given; but they are scarcely necessary unless the rotary action be denied.

Five miles east of the Graham place, the tornado descended a high and steep range of hills which enclose the Whitewater river on the west, prostrating as usual the forest in its descent.

In crossing the valley, it passed through the south part of Harrison. Fortunately the track of destructive violence was here narrowed to two or three hundred feet

The roof of a large church was raised perpendicularly into the air, and carried over the steeple towards the east. A tin ball two feet in diameter on the top of the spire was nearly torn from the iron rod which passed through it. There was no bruise upon it to indicate that it had been struck by a hard body.

The roof of a carpenter's shop was taken off and the posts broken just below the upper story. The lower story was thrown down, and the upper fell back upon the fragments without further injury. Two workmen were in the upper part, and were not aware of their descent till the door, which led to a flight of steps on the outside of the building was opened.

It was supposed by some intelligent observers that the effects produced upon the shop and some other buildings were indicative

of a violent explosive action from within. With one exception I found no evidence of anything more than the usual ascending current in the axis of tornadoes. The windows of the shop were driven in before the roof went off: the gable end of the church fell inside.

Where both walls gave way, one as far as I could ascertain fell in and the other out.

The wall of a small house was sprung out on the north, so that the ceiling was detached. A lady who was in the house at the time stated that the south door was first driven in with great violence.

The exception referred to was a brick house: A portion of the south wall fell outwards, but whether a current of air had found its way to the inside through a door or window could not be ascertained.

Five miles east of Harrison the tornado struck a dense forest. On account of the level surface and the open country around, the position was deemed a favorable one for giving a truthful record of the mode of the storms action. Here as at the Graham place, the track was divided into sections of three rods each, and the bearings of the fallen trees taken with a compass. These bearings are carefully laid down in the plot. The original division of this part of the State into sections of a mile square by the United States, afforded a means of determining accurately the course of the storm.

In crossing five sections, the tornado diverged to the north one and a half miles.

The following table gives the bearings of the last survey; and is inserted for the benefit of those who may be desirous of examining critically the law of storms. The order of the bearings is the same as in the tables belonging to the Brandon storm,—from right to left across the track.

SURVEY ACROSS WAKEFIELD WOODS.

Whole breadth, 66 rods.		Bearings.	Whole breadth, 66 rods.		Bearings.
1st section of 3 rods,	1	E. 5° S.	7th section of 3 rods,	14	N. 77° E.
	2	E. 5° S.		15	N. 45° E.
	3	E.		16	N. 75° E.
	4	N. 45° E.		17	N. 45° E.
2nd " . .	5	N. 52° E.	8th " . .	18	N. 60° E.
	6	E.		19	N. 50° E.
3d " . .	7	E.		20	N. 30° E.
	8	E.	9th " .	21	N. 55° E.
4th " . .	9	E.		22	E. across 20
	10	N. 45° E.		23	N. 45° E.
5th "	11	E.	10th " . .	24	N. 50° E.
6th " . .	12	N. 85° E.		25	N. 30° E.
	13	N. 78° E.			

TABLE—*Continued.*

Whole breadth, 66 rods.			Bearings.	Whole breadth, 66 rods.			Bearings.
11th section of 3 rods,			26 N. 55° E.	15th section of 3 rods,			39 N.
			27 N. 50° E.				40 N. 20° W.
			28 E. over 27				41 N. 6° E.
			29 N.				42 N. 6° E.
			30 N. 20° E.	16th	"	. .	43 N. 6° E.
			31 N. 45° E.				44 S. 68° E.
12th	"	. .	32 E. twisted	17th	"	. .	0 0
			33 E. 5° S. do.	18th	"	. .	45 N. 20° W.
13th	"	. .	34 E. 10° S.	19th	"	. .	0 0
			35 N.	20th	"	. .	46 N. 68° W.
			36 N. 10° E.	21st	"	. .	47 S. 10° E.
14th	"	. .	37 N. 15° E.	22d	"	. .	48 S.
			38 N. 5° W.				

The progressive velocity of the tornado could not be ascertained accurately. It was about ten minutes in passing from Harrison to New Haven, a distance of five miles. This would give thirty miles per hour. This estimate cannot be far from the truth; from some circumstances I am inclined to believe that it is a little too high.

A few general remarks will close this article.

1st. This storm was remarkable for the occasional exhibitions of extreme violence. The Graham place afforded the most striking examples. The house was not merely thrown down, but shivered. A tea spoon was carried half a mile; and a piece of a stove thirty rods. A heavy waggon was carried a few rods and dashed to fragments against a tree. A piece of scantling twelve feet long and three by four inches, was taken thirty rods east, and driven into the ground *three and a half feet.* Four men tried in vain to pull it out; and the writer in connection with Mr. Graham, succeeded only after digging around it to the depth of nearly three feet. The earth thus penetrated was, with the exception of the first six inches, a stiff, yellow clay. What renders this incident more striking, was the fact that the end of the scantling was not pointed. The cross section presented a resisting surface of eight square inches, and the whole amount of earth displaced was equal to 336 cubic inches. According to experiments made at the New York Navy Yard, a shot 6·8 inches in diameter would penetrate earth five feet nine inches. A shot of three inches in diameter, nearly the resisting surface of the scantling, would under similar circumstances penetrate three feet nine inches. This is but three inches deeper than the scantling was driven. While the weight of the timber in question would have been greater than the weight of a three inch shot; on the other hand the form of the end was not so favorable for penetration. What portion of its velocity was due to falling cannot be told with accuracy. As it fell within thirty rods of the building from

which it was taken, it could not have ascended to a great beight. It entered the ground at an angle of about 45°; and if from this we estimate the velocity acquired from falling, to equal one-half of the whole there is still left a velocity of 500 feet per second due to the wind. The effects of such a wind would be fearful indeed: it would move at the rate of 340 miles per hour.

2nd. The involute form of the curve described by the wind as it approached the axis appears more marked in this than in the Brandon storm. The plots of both Surveys indicate this, more especially that at the Graham place. At the same time the cycloidal curve is easily made out. The reverse action of the loop is clearly exhibited at the Graham place; the direct and reverse at Wakefield's. Most of the prostrations at Wakefield's on the right of the axis, were not made by the front of the storm, but took place when about one-half of the cycloid had passed over. Some of the trees were turned outward, showing that they stood till struck by the heel of the storm.

3d. The plunging action of the tornado was a remarkable feature. The ground west of the Whitewater was favorable for observing this, as it was intersected by deep ravines. Ascending slopes were touched lightly in general, or not at all; while the descending were often swept with fearful violence. I am not aware that this peculiarity has been mentioned by other observers. The explanation does not seem difficult; but too much space has already been occupied to state it here.

In conclusion the writer would take the liberty to suggest to observers, that he has found it important to carry his observations beyond the track of greatest violence. Though no trees nor houses may be thrown down, yet valuable evidence to show the mode of action can oftentimes be obtained.

Mr. Laird's house in the vicinity of the Graham place, was on the left of the axis, but too far from it to suffer any injury. The wind was violent but left none of the ordinary marks which could determine its direction. Mr. Laird however stated to the writer that the wind first blew in the south door, and two men were unable to shut it. A moment afterwards, and the north door which had been locked, was violently driven in. The direct and reverse stroke of the loop seem pointed out here. The action of a tornado along the axis only, affords but confused data to elucidate the laws which govern it.

Art. XV.—*On the Geographical Distribution of Crustacea;* by James D. Dana.

(Continued from vols. xvi, xviii, and xix.)

Having in the preceding pages on the geographical distribution of Crustacea, treated of their distribution according to zones of temperature, I now take up the other branch of the subject.—

The Distribution of Crustacea according to Geographical Provinces.

In presenting a series of tables in which the distribution of the Genera is given, I divide the surface of the globe, for marine zoological geography, into three sections, the *Occidental*, the *Africo-European*, and the *Oriental;* the first, including the east and west coasts of America and adjoining islands; the second, the eastern side of the Atlantic Ocean, the coasts of Europe, and also of Africa as far as the Cape of Good Hope; the third, embracing the Indian Ocean, and its coasts and islands, the East Indies and the Pacific Ocean, with its coasts and islands, exclusive of the western coast of America and the neighboring islands. The total number of species in each is given in a separate column.

I make further groupings or subdivisions, by which the several portions of these great regions are distinguished. These general tables are not here copied from the author's Report, and particular explanations therefore need not be given.

The following is an abstract of some of the results:

The division A, includes the Atlantic and Pacific coasts and islands of America; B, the European and West African coasts and islands, from Cape Horn to Greenland inclusive; and C, the coasts and islands of the Indian and Pacific Oceans (America excluded).*

I. BRACHYURA.

	A.	B.	C.
Maioidea.			
Maiinea,	69	24 (1 *a*)†	63 (1 *b*)†
Parthenopinea,	1	5	29
Oncinincea,	0	0	2
Total Maioidea,	70	29 (1)	104 (1)
Cancroidea,			
Cancridæ,	10	3	1
Xanthidæ	17	7 (1 *a*)	129 (1 *b*)
Eriphidæ,	7	5	52 (1 *b*)
Fortunidæ, Platyonychidæ and Podophthalmidæ,	13	19 (1 *a*)	54 (1 *a*)
Telphusinea,	6	1	7
Cyclinea,	1	0	0
Total Cancroidea,	54	35 (2)	243 (3)

* The discrepancies between the enumeration here and the summaries of the preceding tables, arise from species omitted in one or both, on account of the uncertainty of their localities.

† 1*a*, means that 1 of the 24 is identical with a species under A; and 1*b*, that 1 of the 63, is identical with a species under B. So, below.

Grapsoidea,	51	18 (5)	124 (5 *a*)
Leucosoidea,	9	12	48 (1 *b*)
Corystoidea,	6	5	8
Total Brachyura,	190	99 (8)	526 (10)

II. ANOMOURA.

	A.	B.	C.
Dromidea,	1	9	15 (1 *b*)
Bellidea,	2	0	0
Raninidea,	1	0	5
Hippidea,	7	2	7
Porcellanidea,	24	4	19
Lithodea,	5	1 (1 *a*)	3
Paguridea,	26	27 (1 *a*)	61 (1 *b*)
Ægleidea,	2	0	0
Galatheidea,	3	6 (1 *a*)	5
Total Anomoura,	71	49 (3)	115 (2)

III. MACROURA.

	A.	B.	C.
Thalassinidea,	7	8	9 (1 *b*)
Astacidea,	29	9	27
Caridea,	40	77 (3 *a*)	85 (3 *b*)
Penæidea,	4	8	22
Total Macroura,	80	102 (3)	143 (4)

IV. ANOMOBRANCHIATA.

	A.	B.	C.
Squilloidea,	10	16	32 (3 *b*)
Mysidea,	3	18	15
Amphionidea	0	9	11
Total Anomobranchiata,	13	43	58 (3)

V. TETRADECAPODA.

	A.	B.	C.
Isopoda.			
Idotæidea,	11	25	6 (1 *b*)
Oniscoidea,	30	72 (1 *a*)	11
Cymothoidea,	32	57 (1 *a*)	42 (2 *b*)
Total Isopoda,	73	154 (2)	59 (3)
Anisopoda,	10	38	6
Amphipoda.			
Caprellidea,	13	24	6
Gammaridea,	55	114	51
Hyperidea,	9	27	17
Total Amphipoda,	77	165	74
Total Tetradecapoda,	160	357 (2)	139 (3)

The table affords the following lists of genera of the three grand divisions, according to the present state of the science.

1. GENERA EXCLUSIVELY AMERICAN OR OCCIDENTAL.

	Coast on which found.
1. *Maioidea.*	
Microrhynchus,	west.
Salacia,	"
Libidoclea,	west and east.
Libinia,	" "
Pelia,	west.
Rhodia,	"
Pisoides,	"
Thoe,	west and east.
Chorilia,	west.
Scyra,	"
Othonia,	"
Mithraculus,	west and east.
Tyche,	" "
Eurypodius,	" "
Oregonia,	west.
Inachoides,	"
Pugettia,	"
Epialtus,	west and east.
Leucippa,	" "
2. *Cancroidea.*	
Pilumnoides,	west.
Trichodactylus,	east.
Arenæus,	"
Potamia,	west and east.
Orthostoma,	east.
Acanthocyclus,	west.
3. *Grapsoidea.*	
Cyrtograpsus,	east.
Uca,	west and east.
Gecarcoidea,	east.
Fabia,	west.
Pinnixa,	west and east.
Pinnotherelia,	west.
Halicarcinus,	west and east.
4. *Leucosoidea.*	
Platymera,	west.
Hepatus,	west and east.
Guaia,	" "
5. *Corystoidea.*	
Telmessus,	west.
Peltarion,	east.
Pseudocorystes,	west.
6. *Anomoura.*	
Corystoides,	west.
Bellia,	"
Ranilia,	"
Albunhippa,	west.
Echidnocerus,	"
Macroura.	
7. Cambarus,	west and east.
Paracrangon,	west.
Æglea,	"
Cryphiops,	"

2. GENERA EXCLUSIVELY OF THE AFRICO-EUROPEAN DIVISION.

1. *Maioidea.*—Lissa, Stenorhynchus, Amathia, Eurynome.
2. *Cancroidea.*—Perimela, Portumnus, Polybius.
3. *Grapsoidea.*—Gonoplax, Heterograpsus, Brachynotus, Hymenosoma.
4. *Leucosoidea.*—Ilia.
5. *Corystoidea.*—Thia, Corystes.
6. *Anomoura.*—Homola.
7. *Macroura.*—Axius, Calocaris, Ephyra, Gnathophyllum.

3. GENERA EXCLUSIVELY ORIENTAL, OR OF THE THIRD DIVISION.

1. *Maioidea.*—Macrocheira, Paramithrax, Micippa, Lahaina, Naxia, Hyastenus, Pyria, Cyclax, Camposcia, Paramicippa, Tiarinia, Perinea, Halimus, Menæthius, Stenocionops, Huenia, Xenocarcinus, Parthenope, Eumedonus, Ceratocarcinus, Gonatonotus, Eurynolambrus.
2. *Cancroidea.*—Atergatis, Liomera, Liagora, Medæus, Halimede, Etisus, Carpilodes, Zozymus, Daïra, Cymo, Polydectus, Œthra, Galene, Pseudozius, Melia, Acanthodes, Actumnus, Ruppellia, Domæcius, Trapezia, Tetralia, Quadrella, Scylla, Charybdis, Lissocarcinus, Podophthalmus.
3. *Grapsoidea.*—Curtonotus, Cleistostoma, Macrophthalmus, Helœcius, Scopimera, Doto, Eriocheir, Platynotus, Trichopus, Sarmatium, Helice, Gecarcinicus, Xenophthalmus, Xanthasia, Hymenicus, Elamena, Myctiris.
4. *Leucosoidea.*—Mursia, Orythia, Thealia, Matuta, Philyra, Leucisca, Nucia, Nursia, Myra, Ixa, Iphis, Arcania, Oreophorus, Tlos, Ethusa.

5. *Corystoidea.*—Kraussia, Œidia, Dicera.

6. *Anomoura.*—Caphyra, Raninoides, Ranina, Notopus, Lyreidus, Cosmonotus, Lomis, Diogenes, Aniculus, Birgus.

7. *Macroura.*—Laomedia, Glaucothoe, Callianidea, Callisea, Thenus, Ibacus, Astacoides, Paranephrops, Cyclorhynchus, Atyoida, Alope, Œdipus, Harpilius, Anchistia, Palæmonella, Hymenocera, Oplophorus, Regulus, Stenopus, Spongicola, Acetes, Eucopia.

4. GENERA COMMON TO THE AMERICAN AND AFRICO-EUROPEAN DIVISIONS, BUT NOT IN THE THIRD, OR ORIENTAL.

1. *Maioidea.*—Hyas, Herbstia, Leptopodia, Stenorhynchus.
2. *Cancroidea.*—Atelecyclus.
3. *Anomoura.*—Munida, Grimothea.
4. *Macroura.*—Homarus.

5. GENERA COMMON TO THE AFRICO-EUROPEAN AND ORIENTAL DIVISIONS, NOT YET FOUND IN THE OCCIDENTAL.

1. *Maioidea.*—Inachus, Doclea, Maia, Achæus, Lambrus.
2. *Cancroidea.*—Actæa, Actæodes, Thalamita, Portunus, Telphusa.
3. *Leucosoidea.*—Cycloes, Ebalia, Dorippe.
4. *Anomoura.*—Latreillia, Cymopolia, Remipes.
5. *Macroura.*—Nika, Lysmata, Caridinia.

6. GENERA COMMON TO THE THREE DIVISIONS.

1. *Maioidea.*—Pisa, Mithrax (mainly Occid.), Acanthonyx.

2. *Cancroidea.*—Xantho, Panopæus (mainly Occidental), Pilumnus, Eriphia, Lupa, Amphitrite, Carcinus, Platyonychus.

3. *Grapsoidea.*—Grapsus, Goniograpsus, Sesarma (sparingly European), Acanthopus, Plagusia, Pinnothera, Calappa.

4. *Anomoura.*—Dromia (sparingly Occid.), Albunæa, Porcellana, Lithodes, Paguristes, Bernhardus, Pagurus (mainly Orient.), Clibanarius, Galathea.

5. *Macroura.*—Gebia, Scyllarus, Panulirus, Palinurus, Astacus, Crangon, Alpheus, Betæus, Hippolyte, Pandalus, Palæmon, Sicyonia, Penæus.

The following are lists of *species* common to two or more of the three divisions. They may be much changed by farther study, through the discovery that the specimens from distant localities are not conspecific. Should this happen, there is a relation indicated based on their close similarity, which is important.

1. SPECIES STATED TO BE COMMON TO DIVISIONS A. AND B., OR THE AMERICAN AND THE AFRICO-EUROPEAN WATERS.

Hyas coarctata: Massachusetts and Long Island, in United States; France; England; Shetlands.

Leptopodia sagittaria: Canaries; West Indies; Valparaiso.

Panopæus Herbstii: Mediterranean; Key West, South Carolina, and New York in United States.

Carcinus mænas: Mediterranean at Nice; Crimea; England; Massachusetts, United States.

Grapsus pictus: Madeira; Peru and Chili; (also various Pacific islands).

Planes minutus: Atlantic Ocean, and occasionally found on both the American and European coasts.

Goniograpsus varius: Canaries; Mediterranean at Algiers, Nice, Italy; Crimea; Brittany; and probably at Rio Janeiro, Brazil.

Sesarma reticulata: Key West and South Carolina, in United States; and in South Africa, according to McLeay.

Acanthopus planissimus: West Indies; Canaries; Madeira; Cape Town and Port Natal, South Africa; (also various tropical Pacific islands).

Plagusia squamosa: West Indies; Key West, South Carolina, in United States; Canaries; Madeira (also, Isle of France; Indian Ocean; Red Sea; Port Natal).

Plagusia tomentosa: Chili; Cape Town; (also New Zealand).

Albunæa symnista: Canaries; Mediterranean (also Pondicherry); and if the *A. oxyophthalmus* is the same species, it occurs in the West Indies, and on the coast of South Carolina.

Lithodes Maia: Great Britain; Shetlands; Norway; coast of Massachusetts (rare).

Bernhardus streblonyx: Great Britain; France; Mediterranean; Norway; Massachusetts, in United States; (also Kamtschatka).

Cenobita diogenes: West Indies; Mediterranean, (Hawaii ?).

Crangon vulgaris: Great Britain; France; United States; San Francisco and Puget's Sound, Western America.

Crangon boreas: Norway; Iceland; Greenland; Massachusetts (in fish); (also, Kamtschatka).

Pandalus annulicornis: Scotland and Shetlands; Norway; Iceland; Massachusetts (rare).

Gonodactylus chiragrus: Mediterranean; Key West; (also, Red Sea; Port Natal, South Africa; Isle of France; East Indies; Swan River, Australia; Pacific Ocean, at Feejees, Tongatabu, &c.).

2. SPECIES COMMON TO B. AND C., THE AFRICO-EUROPEAN AND ORIENTAL SEAS.

Mithrax dichotomus: Mediterranean; East Indies.

Achæus Cranchii: Mediterranean; *Japan* (probably same species).

Actæa rufo-punctata: Canaries and Mediterranean; Isle of France, Indian Ocean.

Thalamita admete: Canaries; Port Natal, South Africa; Red Sea; Indian Ocean, and East Indies; Pacific Ocean, at the Fejees, Samoa, Hawaiian Islands, Wake's Island, &c.

Pilumnus Forskalii: Canaries; Red Sea.

Grapsus pictus: see above.

Grapsus strigosus: Canaries: South Africa; Red Sea; East Indies.

Goniograpsus messor: Canaries; Port Natal, South Africa; Red Sea; East Indies.

Planes minutus: Atlantic; *Japan.*

Acanthopus planissimus: see above.

Plagusia tomentosa: Chili; South Africa; New Zealand.
Plagusia squamosa: see above.
Cycloes granulosa: Canaries; *Japan* (probably same species).
Remipes scutellata: Ascension Island; Swan River, Australia; St. Christopher's.
Lysmata seticaudata: Mediterranean; *Japan.*
Alpheus Edwardsii: Mediterranean; Cape Verdes; Port Natal, South Africa.
Pandalus pristis: Mediterranean; *Japan.*
Squilla mantis: Mediterranean; Canaries; *Tschusan.*
Pagurus striatus: Mediterranean; Japan.

3. COSMOPOLITES.

The above lists include the following species occurring in the Occidental, Africo-European, and Oriental seas.

Grapsus pictus.	Bernhardus streblonyx.
Acanthopus planissimus.	Crangon boreas.
Plagusia sqamosa.	Crangon vulgaris.
Plagusia tomentosa.	Gonodactylus chiragrus.

These are cosmopolite species.* The *Grapsus*, *Acanthopus*, *Plagusia*, *squamosa* and *Gonodactylus* preëminently deserve this name, being found both north and south of the equator. They thrive in the hottest equatorial waters, and have their extreme limit in the temperate region. The temperature they admit of is hence at least from 56° to 88° F.

The other species are cold-water species. *Plagusia tomentosa* belongs to the southern subtemperate region, being reported from Cape Town, New Zealand, and Chili, and the rest are found in high northern latitudes, and probably pass from the Atlantic to the Pacific Ocean through the Arctic Seas.

Besides the above species, a few are found in the West Indies, which occur also in the Oriental Seas, but are not yet known from the European or West African coasts. These, which also may be styled cosmopolites, are as follows:

Mithrax asper: East Indies; probably the same on the Peruvian coasts.
Atergatis lobatus: Red Sea and Indian Ocean; West Indies.
Carpilius maculatus: East Indies; South France; Japan; various Pacific Islands from the Paumotus to the Feejees and Hawaiian Islands; West Indies; Eriphia gonagra; East Indies; Port Natal; Key West.
Menippe Rumphii: East Indies; Rio Janeiro and the West Indies.
Chlorodius exaratus: Pacific Islands; East Indies; West Indies.
Lysiosquilla scabricaudis: Indian Ocean; West Indies; Brazil; South Carolina.

* The *Platyonychus bipustulatus* may possibly be another cosmopolite, for it is reported from Table Bay, the East Indies, Japan and Valparaiso. But we believe the Valparaiso species to be different from that of the East Indies, and have so named it.

From the survey already made, it is apparent, that the three grand divisions of the seas and coasts adopted in the preceding table, have very few species in common, and they correspond to a natural geographical arrangement. They constitute three kingdoms, to which two should be added, one for the Arctic Seas, and the other for the Antarctic. These kingdoms are:

I. The *Occidental* Kingdom, embracing the Atlantic and Pacific coasts of America to the frigid region, or some point in the subfrigid region.

II. The *European* Kingdom, extending from Cape Horn (or Cape Agulhas) to the Shetlands inclusive, and embracing the adjoining islands.

III. The *Oriental* Kingdom, including the east coast of Africa, the south and east of Asia, and the islands of the Indian and Pacific Ocean, exclusive of the American continent.

IV. The *Arctic* Kingdom, including Norway, Iceland, Greenland, the Alascha Archipelago, and adjoining parts of the coasts of America und Kamtschatka, with other Arctic lands.

V. The *Antarctic* Kingdom, embracing Fuegia, the Falklands, Southern New Zealand, and the lands or islands of the Antarctic Seas.

It will not be understood that the torrid species in one of these kingdoms resembles the temperate more than do the torrid of another kingdom; for this is far from true, since the distribution of genera is to a great extent determined by temperature, as already shown. But taking the range of species of the kingdoms through, there is a striking difference between the kingdoms in species of the same temperature region or zone.

Each of the first three kingdoms are naturally divided into three subkingdoms: a *north*, a *middle*, and a *south*, corresponding severally to the North Temperate, Torrid, and South Temperate zones of sea temperature. The importance of these divisions will be a subject of further remark beyond.

The summary of the results in the preceding table, presents some striking facts.

We observe, first, that there is a ratio of 1 : 1·5 between the Maioids of the A and C divisions (that is between those of the *Occidental* and *Oriental* seas, as just explained), while the ratio is about 1 : 4½ for the Cancroids. So also, while the ratio of the A and B divisions together (Occidental and European) to C (Oriental) is for the Maioids, nearly 1 : 1, it is for the Cancroids, 1 : 3. Here is a wide difference between the Occidental and Oriental seas as regards these groups. This last ratio is for the Corystoids nearly that for the Maioids, or more exactly, 1 : 0·75; and for the Grapsoids it is 1 : 2; for the Leucosoids, 1 : 2½. (The Arctic and Antarctic Seas are here merged in the other kingdoms, with which they are most nearly associated.)

If we compare these ratios with those which the same groups sustain as regards temperature, as exhibited on a former page, we discover that there is a very close parallelism; showing plainly that the prevalence of Maioids in the Occidental Seas must be owing to the comparative prevalence of cold waters; and the prevalence of the warm water groups, the Cancroids and Leucosoids, in the Oriental Seas, is owing conversely to the great extent of warm waters.

Again, the ratio between the A and B divisions together of the Macroura, and the C division, is nearly as 1 : 0·8, which sustains the same conclusion as to the influence of temperature.

The corresponding ratio for the Tetradecapoda is as 1 : 0·26. But as this group, owing to the smallness of the species, has not been thoroughly investigated, except in European regions, directly under the eyes of European observers, we cannot use satisfactorily the facts they present for deducing general conclusions, or for characterizing zoological districts or provinces. Still, it should be observed that the facts conform to the same principle.

It is hence of the highest importance before comparing the zoological character of different coasts, that the temperature-regions of those coasts should be ascertained.

Comparative tables of the East Indies and Mediterranean, or of the Peruvian coast and the East Indies, or of the southeast and southwest coast of Africa (and so on), would lead us far astray, if this element were left out of view; for a difference of temperature region, implies a difference of genera and species, independent of other considerations. On these grounds, whole continents, or sides of continents, may have a common character and differ widely from other continents in the same latitude.

If we look at the American continent in this point of view, we at once perceive a striking peculiarity. All the coasts of North and South America with the Gallapagos on the west belong to the Temperate zone, excepting a few degrees along by Panama, and a connected range of coast from Key West to Rio Janeiro. Chili and Peru are excluded even from the warm temperate region, and so also, the coast of the United States, north of Cape Hatteras. (See Chart, this Jour., vol. xvi.)

Now contrast America with the Oriental Seas. The whole east coast of Africa, north of the parallel of 30° south, the coasts of India and the East India Islands, and the northern half of Australia, together with the numerous islands of the Pacific, belong alike to the Torrid zone. In the American Seas, the torrid coasts make a single range, and have many species in common throughout. In the Oriental Seas, they reach with an uninterrupted surface over one-half of the circumference of the globe, and there is room for many distinct provinces within the same temperature region. The fact is more striking, if we consider that the At-

lantic east of the West Indies contains no islands in the Torrid zone, besides St. Helena, Ascension, and the Cape Verdes, all of which are of small size.

Again in order to compare the coasts of America and Europe, we must observe that the warm temperate region is represented along the former by a small district from Northern Florida to Cape Hatteras, while this region does not reach at all the latter, and only the Canaries in the Eastern Atlantic are within it. Moreover, the temperate and subtemperate regions have no existence on the North American coast at Cape Hatteras; while on the European side, the former embraces the larger part of the Mediterranean, and a portion of North-western Africa, and the latter includes the Atlantic coast of Portugal. But north of Cape Hatteras, the coast of America is rightly compared with that of Europe, north of Portugal.

To compare the coast of Asia and Europe, we first observe in the same manner the temperature regions. There is in fact a striking similarity with the coast of the United States. Yet, the torrid and subtorrid regions are confined to limits much nearer the equator; and the warm temperate, although embracing as many degrees of latitude as the warm temperate on the United States, does not, on the China coasts extend farther north than the subtorrid region of the Florida coast. The temperate region hardly has a place on the coast of China, while the subtemperate occupies the Yellow Sea. North of this Gulf, the coast corresponds mostly with the coast of the United States, north of Cape Cod.

It is unnecessary to adduce other explanations, as the chart furnishes all that is needed for a ready comparison between the different coasts.

The propriety of uniting in one kingdom both coasts of America, the eastern and western, and thus shutting off the latter from the great Pacific Ocean, may at first appear unnatural. Yet it is supported by all facts bearing on the subject. There are no species known to be common to Western America and the Middle Pacific, excepting two or three cosmopolites. Moveover, the genera are to a great extent distinct, and where so, they often occur on both sides of the continent. The genera of Podophthalmia peculiar to America are mentioned on a preceding page, and also the particular coast on which they occur.

A review of some of the facts will exhibit in a strong light the zoological resemblances of the two sides of the continent.

Of *Cancer*, there are *four* species found on the west coast of South America, *three* on the west coast of North America, and *two* on the east coast of North America.

Of *Hepatus*, there is *one* species common to the West Indies and Brazil, a *second*, found at Rio Janeiro; a *third* at Valparaiso, Chili; a *fourth* on the Carolina coast.

Libinia, in the same manner, has its species on the Atlantic and Pacific coast of the United States, and the coasts of Western and Eastern South America. *Mithrax* is as widely distributed.

Epialtus occurs in the West Indies, California, Brazil, Gallapagos, and Valparaiso. *Potamia* has two West Indian and one Chilian species.

Eurypodius of Southern South America has its representative at Puget's Sound, in the genus *Oregonia*.

Again, the *Libinia dubia* of the West Indies, is hardly distinguishable, according to Prof. L. R. Gibbes, from the *L. affinis*, Rand., of the California coast. *L. spinosa* of Brazil, is also found in Chili. *Leptopodia sagittaria* occurs in the West Indies, and also, according to Bell, at Valparaiso; *Acanthonyx Petiverii* (?), in the West Indies, Brazil, and Gallapagos; *Epialtus marginatus*, on the coast of Brazil and at the Gallapagos (Bell); *Epialtus bituberculatus*, in Chili, and at Key West; *Uca una*, Guayaquil and West Indies; *Albunæa scutellata*, West Indies and San Lorenzo, Peru; *Hippa emerita* and *talpoides*, both on East and West America, North and South.

It is obvious, therefore, that the east and west sides of America are very closely related, and differ widely in a zoological sense, from either of the other kingdoms.

We observe further, that nearly all the genera peculiar to America are *cold-water* genera. They are mostly Maioids; the large group of the Cancroids, which belong mainly to warm waters, does not include a single genus exclusively American, and of the family Leucosidæ, of the Leucosoids, there are only three known species.

We also perceive why the western coast of America has no zoological affinity with the Pacific Islands. The temperature of their waters is widely different; and, moreover, the oceanic currents of the tropics run *from* the American coast to the westward, and are a barrier to migration eastward.

The relations of the American or Occidental to the Afrieo-European kingdom are of much interest. The two kingdoms are widely different in most respects.

In the first place, the genera *Lupa*, *Gelasimus*, *Ocypoda*, *Libinia*, *Epialtus*, *Hepatus*, well represented on the American coasts, are not known on the European, besides others (Table 1, on a preceding page) of less prominence.

Again, there are several genera common in Europe, not known in America, as *Inachus*, *Maia*, *Achæus*, *Portunus*, *Ebalia*, *Latreillia*, *Athanas*, in addition to those included in Table 2.

Still, the American and Africo-European kingdoms have a common character separating them from the Oriental. For example: the great genus *Cancer* occurs in both of these kingdoms,

and is not known in Oriental seas, except in New Zealand and Tasmania. So also the important genus *Homarus*; besides *Hyas*, *Herbstia*, *Leptopodia*, *Atelecyclus*, *Munida*, and *Grimothea*. The genus *Homarus* has one species on the coast of Europe, and one at Table Bay, South Africa, thus ranging over the whole Atlantic.

We may now treat separately of the several Kingdoms, and their subdivision into *Provinces*, pointing out the naturalness of their limits, and the characteristics of these Provinces. Each temperature region along a coast makes a distinct Province, which facts, where ascertained, show to be well characterized. In some cases, a further subdivision may be desirable, and when so, the subordinate divisions may be called *Districts*. In each Kingdom, the Provinces of each zone together may constitute a *Sub-kingdom*, as the *Torrid* Subkingdom, *Temperate* Subkingdom, &c.

ART. XVI.—*On the Grooving and Polishing of hard Rocks and Minerals by dry Sand;* by WILLIAM P. BLAKE.

THE phenomena about to be described were observed in the Pass of San Bernardino, (California) in 1838.* This Pass is one of the principal breaks through the southern prolongation of the Sierra Nevada, and connects the Pacific slope with the broad and low interior plain of the Colorado Desert. It is bounded on each side by high mountains; the peak of San Bernardino rising on the north to the height of about 8500 feet, and San Gorgonio, on the south to about 7000. The elevation of the summit level is 2808 feet above the Pacific, and the width of the gap at that point is about two miles: from this the ground slopes each way very gradually, the grade or descent on the east, for about 28 miles, being on an average, 69 feet per mile.

On this eastern declivity of the Pass—the side turned toward the Desert—the granite and associate rocks which form the sharp peak of San Gorgonio extend down to the valley of the Pass in a succession of sharp ridges, which being devoid of soil and of vegetation, stand out in bold and rugged outlines against the clear unclouded sky of that desert region.

It was on these projecting spurs of San Gorgonio that the phenomena of grooving were seen. The whole surface of the granite, over broad spaces, was cut into long and perfectly parallel grooves and little furrows, and every portion of it was beautifully smoothed, and though very uneven, had a fine polish. For a moment it was impossible to realize the cause of all this abra-

* A brief notice of these phenomena is given in the writer's Preliminary Geological Report, accompanying the Report of Lieut. R. S. Williamson, of a Reconnoissance in California, House Doc., 129, p. 27. Washington, 1855.

sion performed in a manner so peculiar; the action of glaciers and drift was thought of in succession; but the appearance of the surface was so entirely different from that of rocks which have been acted on by these agents, that I could not regard them as the cause. While contemplating these curious effects, the solution of the problem was presented. The wind was blowing very hard, and carried with it numerous little grains of sand. When I stooped down and glanced over the surface of the rocks, I saw that they were enveloped in an atmosphere of moving sand, which was passing over and accumulating in deep banks and drifts on the lee side of the point. Grains of sand were thus pouring over the rocks in countless myriads, under the influence of the powerful current of air which seems to sweep constantly through this Pass from the ocean to the interior.

Wherever I turned my eyes—on the horizontal tables of rock, or on the vertical faces turned to the wind—the effects of the sand were visible: there was not a point untouched, the grains had engraved their track on every stone. Even quartz was cut away and polished; garnets and tourmaline were also cut, and left with polished surfaces. Masses of limestone looked as if they had been partly dissolved, and resembled specimens of rock-salt that have been allowed to deliquesce in moist air. These minerals were unequally abraded, and in the order of their hardness; the wear upon the feldspar of the granite being the most rapid, and the garnets being affected least. Whenever a garnet or a lump of quartz was imbedded in compact feldspar and favorably presented to the action of the sand, the feldspar was cut away *around* the hard mineral, which was thus left standing in relief above the general surface. A portion however, of the feldspar, on the lee side of the garnets, being protected from the action of the sand by the superior hardness of the gem, also stood out in relief, forming an elevated string, osar-like, under their lee.

When the surface acted on, was vertical and charged with garnets, a very peculiar result was produced; the garnets were left standing in relief, mounted on the end of a long pedicle of feldspar, which had been protected from action while the surrounding parts were cut away. These little needles of feldspar tipped with garnets, stood out from the body of the rock in horizontal lines—pointing like jeweled fingers in the direction of the prevailing wind.

They form in reality a perfect index of the winds' direction, recording it with as much accuracy as the oak trees do, in the region about San Francisco, where they are all bent from the perpendicular in one direction, or in some places lie trailed along the ground. All these little fingers of stone pointed westward, in the direction of the valley of the Pass, to which the wind conforms. We experienced this wind before reaching the point of rocks and

the sand drifts: it blew with great force and seemed to be a great air current, as uniform in its direction and action, as the great currents of the sea. It flows into the interior with singular persistence and velocity, sweeping down over the slope of the Pass, not in fitful gusts and eddying whirls, but with a constant uniformity of motion unlike any of the winds of our Atlantic seaboard, or of the plains.

The Pass would in fact appear to be a great draught-channel, or chimney, to the interior, through which the air rushes inland from the cool sea, to supply the vacuum caused by the ascent of a column of heated air from the parched surface of the great Desert. This Pass is the only break of any magnitude in the mountain chain for a long distance, and as an air-channel, holds the same relation to the Colorado Desert as is sustained by the Golden Gate, at San Francisco, to the broad interior valleys of the Sacramento and San Joaquin.

The effects of driving sand are not confined to the Pass; they may be seen on all parts of the Desert where there are any hard rocks or minerals to be acted upon. On the upper plain, north of the Sand Hills, where steady and high winds prevail, and the surface is paved with pebbles of various colors, the latter are all polished to such a degree that they glisten in the sun's rays, and seem to be formed by art. The polish is not like that produced by the lapidary, but looks more like laquered ware, or as if the pebbles had been oiled and varnished.

On the lower parts of the Desert, or wherever there is a specimen of silicified wood, the sand has registered its action. It seems to have been ceaselessly at work and when no obstacle was encountered on which wear and abrasion could be effected, the grains have acted on each other, and by constantly coming in contact have worn away all their little asperities and become almost perfect spheres. This form is evident when the sand is examined by a microscope.

We may regard these results as most interesting examples of the denuding power of loose materials transported by currents in a fluid. If we can have a distinct abrasion and linear grooving of the hardest rocks and minerals, by the mere action of little grains of sand, falling in constant succession and bounding along on their surface, what may we not expect from the action of pebbles and boulders of great size and weight, transported by a constant current in the more dense fluid-water? We may conclude that long rectilinear furrows of indefinite depth may be made by loose materials, and that it is not essential to their formation that the rocks and gravel, acting as chisels or gravers, should be pressed down by violence, or imbedded in ice, or moved forward *en masse* under pressure by the action of glaciers or stranded icebergs. Wherever, therefore, we find on the surfaces of moun-

tains, not covered by glaciers, grooved and polished surfaces with the furrows extending in long parallel lines seeming to indicate the action of a former glacier, we should remember the effects which may be produced during a long period of time by light and loose materials transported in a current of air; and which consequently may be produced with greater distinctness, and in a different style, by rocks moved forward in a current of water. The effects produced by glaciers, by drift, or moving sand, are doubtless different and peculiar—so different and characteristic, that the cause may be at once assigned by the experienced observer, who can distinguish between them without difficulty. It is, however, possible that after a sand-worn surface, such as has been described, has been for ages covered with moist earth, a decomposition of the surface would take place sufficient to remove the polish from the furrows and leave us in doubt as to their origin.

If it were possible, it would be exeedingly interesting to ascertain the length of time it has required for the little grains of sand to carve the surface of the granite ridge to its present form. How inappreciably small must be the effect produced by a single grain! And yet by their combined and long continued action mighty effects are produced. That the action of the grains singly, is not visible, is proved to us by the polished surface, for no one grain cuts deeply enough to leave a scratch. Ages have doubtless elapsed since this action of the sand began, and we cannot tell how deep the abrasion has extended; cubic yards of granite may have been cut into dust and driven before the wind over the expanse of the Desert.

ART. XVII.—*The Vegetable Individual in its relation to Species;** by Dr. ALEXANDER BRAUN.—Translated from the German by CHARLES FRANCIS STONE.

PART II.†

As I attempted to show in Part I, whatever seems arbitrary and indefinite in the existing views of what constitutes the Vegetable Individual has its ground in the nature of plants themselves, which, in their realization are resolved into a plurality which they are not capable of reducing to as complete an unity as animals are. As we ascend in the natural kingdoms, individ-

* Das Individuum der Pflanze in seinem Verhältniss zur Species,—Generationsfolge, Genrationswechsel und Generationstheilung der Pflanze, by Dr. A. Braun, Professor of Botany in the University of Berlin, &c. &c.

† For Part I, see Number for May, 1855.

uals increase in importance, until they reach their most perfect independence in Man. Hence, if we would appreciate them justly in the lower departments, in which their character is less definite, we must try to comprehend the less perfect structures by starting from the more perfect ones: to appreciate vegetable individuals we must start from a comparison of animal individuals. From this point of view we perceive at once that the cell cannot be regarded as the proper individual in plants, otherwise it would have to be considered in the same manner in animals. Cell-formation is a property common to plants and animals: but in animals it appears far more obviously as a subordinate element in the organization of the whole body, than it does in plants; since the animal cell, in most cases, is not so independent, nor so determinate, nor so permanently isolated as the vegetable cell. For this reason, too, it is rarer to find the animal cell considered as the proper animal individual, although *Schwann* has shown that animal cells are analogous to vegetable cells and may be as justly considered individual organisms as they. Yet as mere *curiosa* we might adduce the somewhat similar assertion of Gaillon, that "men and animals are properly masses of Infusoria;" and Oken's doctrine of generation, "a synthesis of Infusoria," might, perhaps, be interpreted in the same sense. The "stories" of the axes, the internodes with their leaves, might claim to be compared with the animal individual with more justice than the cell, especially if leaf-formation really took place as the defenders of such doctrines have represented: that is, if every successive leaf were produced as a *new* structure out of the old one (out of its base which becomes the internode), and if the whole stem were thus merely a concatenation of leaves shooting out of and growing above each other. But this is not so; the rudiment of the stem as an uninterrupted growth ("continuance") is formed *before* the leaves, while the latter, emerging as developments of the upper surface of the stem, are evidently members dependent upon and belonging to the axis, and forming with it one whole. Hence the structure of the internodes may be more aptly compared with the lateral structure of the animal body, and that of the leaves with its terminal structure. Thus we arrive at the shoot; and we must investigate the question, whether it should be considered as what corresponds best with the animal individual, or whether we must ascend still farther, up to the whole plant-stock.

The Shoot as the Vegetable Individual.

The first and most common view is that which considers the individual in plants, as in animals, to be merely each single specimen, i. e., each representative of the species which appears to be one whole from the connexion of its parts. To some extent

this view is correct, for in a forest of trees of the same genus and species, in a meadow, or in a cornfield, each single tree, each stock of grass or of grain, appears as a single member of its species, as each single beast does in a flock of animals forming a community. But the question arises whether these individual beings, regarded as such in this superficial way, can each be considered individuals in the same sense. When the flocks or societies of animals are numerous, as in an apiary, each hive or swarm will appear as an individual member of its species, and the more so in proportion to the closeness of the connexion between the members of such a community. Many flocks of animals whose members are organically connected during life, have until lately been considered to be individual animals; and even when the separation of the individuals is more complete, such conceptions are to a certain extent justified as long as the community is really a natural growth—when in fact it consists of members of one single stock—and we are not surprised to find that the oldest history of the human race describes the family itself, and the tribe which springs from it, as one person, named after its patriarch. As regards the plant-stock, even a superficial examination shows us peculiarities which will hardly allow us to consider it as an individual in the precise meaning of the term, and which calls upon us carefully to consider whether it is to be regarded as such an individual, or merely as an individual in the broader sense,—as one united family. Even our feelings aroused by the sight of the most ramified plant-stocks,—especially by a tree with its numerous branches, with the thousands of blossoms and fruits which it bears, and the numberless buds through which it will deck itself again in the following year with leaves and flowers—excite the presentiment that this is not one single being, one single life, comparable with the animal or the human individual, but rather a world of united individuals which have sprung from each other in a succession of generations, and although they do not separate, going through their particular cycles of existence,—here dying off, there reproduced, and thus building themselves up in uninterrupted succession into a family-tree, perennially laden with an increasing posterity. That such a view, so consistent with our healthy natural feelings, is corroborated by scientific investigation, I hope to show in the following observations.

Comparing plants with animal individuals, it is at once evident that the tree loses annually flowers and fruit,—the highest and noblest structures which vegetable life produces,—to generate them again in the following period of vegetation. Even the whole dress of the tree, even its foliage when compared with the trunk and branches, is only a superficial growth periodically dying off, and reproduced by the succeeding generation: in

the paradoxical words of Schleiden:* "No tree has leaves." The leaves, in fact, never grow out of the woody portions of the tree, but only on its herbaceous extremities, which grow upon the woody stem as upon a ground formed by the process of vegation. This common ground, namely the woody stem, which is almost lifeless in comparison with the herbaceous parts engaged in active growth, is annually covered with a vigorous sheath under the protecting bark, and this sheath is the ground of the nourishment of all the vegetating herbaceous extremities. This sheath is the so-called *cambium*, a layer of active, living tissue which, contemporaneously with the lignification of the herbaceous extremities of the branches, becomes a new woody layer, united to the old trunk in the form of an annual ring—to be covered in its turn in the following period of vegetation with a new layer, which, again, will be the immediate supporter of the new generations. The history of the grand development of nature on the surface of our globe presents an analogy which may perhaps serve to set this relation in a clearer light. The successive geological formations superposed during the course of countless ages, present, buried in their depths, the traces of as many formations of the organic world, each of which carpeted the then superior stratum of the earth with a new life, until it found its own grave in the succeeding formation, when a new uprising of organic life took its place. In the same way the stem of a tree is a multistratified ground, in whose layers the history of earlier growths are legibly preserved. The number of the woody layers indicates the number of the generations which have perished, i. e., the age of the whole tree; a distinct annual ring is the monument of a vigorous season, an indistinct one of a bad season, a sickly one (which is often found among healthy ones) indicates the unhealthiness of the foliage of that particular year. The practised woodman can decipher many facts of the past in the layers of the trunk, e. g., a good season for foliage or for seed, damage by frost or by insects, etc.

Essentially the same relations as those seen in the tree, or the shrub, are to be found in the subterranean perennial growth of plantæ redivivæ (herbaceous perennials) whose subterranean stem (rhizoma), like the stem above the surface, emits annually a new generation of herbaceous growths; whose stalks however, unlike those of the tree, do not lignify and form a part of the common supporter, but die off wholly, or mostly, at the close of the season of vegetation.

The relations indicated above compel us to recognise a succession of generations in trees, shrubs, and perennial herbs; and

* *Beitr.*, p. 152, where the following view of the arboraceous stem, as a common ground bearing many individuals is developed; but this whole view, after all, needs to be corrected by a precise limitation of its meaning by what follows it.

thus our first idea of them as individuals is necessarily modified. Another remark may be made here which confirms our idea thus modified. Natural *death* closes the life of the individual.* The development of the life of individuals in organic nature has a goal, an acme; after it has attained this goal its course draws to an end. This is not the case in the tree and the perennial herb. True the tree is destroyed by time; but this seems to result more from external, and in part mechanical causes, than from any internal decrepitude. The more numerous the generations which the tree builds up, one above the other, the greater is the distance of the growing extremities from the source of their nourishment; the thicker the supporting trunk the thinner is the layer of cambium which connects the new shoots with the extremities of the root by which the nourishment is absorbed. This increased difficulty of communication between the upper and lower extremities is probably the cause of the decrease of vigorous growth after the plant has arrived at a certain age. But in most cases external casualties are superinduced, which accelerate the termination of the tree's life. It is injured by wind and weather, the decay of the injured part spreads through the whole organism, various fungi fix themselves upon the tree, and are especially fatal when they attack the roots. Oftentimes the tree breaks down under the weight of the productions of its own vital powers, the luxuriance of its fruit. These statements are corroborated by the cases of trees of unusual age, now so well known through De Candolle's investigations. One of the examples adduced by him shows in particular that those trees whose branches have been prevented from breaking down by props or supports attain to a great age. I refer to the celebrated Linden in Neustadt on the Kocher, which, as early as 1229, was the cause of the town's being called "Neustadt an der grossen Linde" (Neustadt of the great Linden), whose wide-spreading branches were supported already in 1408 by sixty-seven stone pillars, and this number was afterwards increased up to more than one hundred.† The hoary tree still flourishes, having survived its many scientific admirers, among whom was my predecessor, to whom Botany is so greatly indebted, who visited and described it a few years ago, (in 1849).‡ Natural

* Cf. *Schleiden: Beitr.*, p. 151. "The idea of individual life necessarily implies as its distinguishing characteristic individual death, preconditioned in the organization itself." Although this remark is not universally true in many respects, yet I have adopted it for the light it is calculated to throw on the nature of the tree. For the very reason that natural death is the result of a determinate conclusion of the development, those shoots (vegetable individuals) which have no such conclusion frequently undergo no death at all except that of some of their parts: but this is a concomitant of animal life itself, (casting the skin, moulting, and the organic changes in the body). Cf. on this point Roeper: Linnæa, 1826, p. 439, and the following remarks on *Paris*, *Lysimachia nummularia*, *Adoxa*, etc., and the preceding ones on *Caulerpa*.

† *De Candolle: Physiol. Veg.* II, p. 988.

‡ *Link:* Erinnerungen an die grosse Linde bei Neustadt am Kocher (Flora, 1850, No. 8).

supports are more efficacious in preserving trees than even artificial ones; since they not only prop the branches, but conduct nourishment to them by a shorter road, as is actually found to be the case in *Rhizophora Mangle*, in various species of figs, [Banyan, &c.], and other tropical trees, whose branches high in air send down strong roots into the earth. A similar example nearer home, though indeed on a much smaller scale, is found in the *Juniperus Sabina*. Its branches, which spring from a low stem, curve down to the earth, strike numerous roots, and raise themselves again, so that the comparatively feeble stem may carry a creeping crown of considerable extent, like a thick wood continually spreading, and which may continue to flourish in its parts, even when the communication between the original supporter and nourisher of the whole colony and the succeeding new growths, which are constantly receding from it, has finally ceased. A remarkable specimen of this tree stands in the Royal Botanical Garden at Schöneberg, which, if not as old as the Garden itself, which was laid out in 1679 under the great Elector, Frederic William, certainly dates as far back as Gleditsch's time, and his directorship commenced in 1744. The main stem is not more than 33 inches in circumference at eight inches above the ground, close under the place where the first branches originate; the centre-piece of the crown which belongs immediately to the stem, is only nine feet high, and has been dying off during several years, while the maximum diameter, from S. W. to N. E., of the hundred-rooted crown, which has spread out over the ground by the declination of the branches, measures 35 feet; the entire circumference of the crown, which amounts to about 100 feet, would be still more considerable if it had been permitted to spread on every side, and if the branches on the N. E. side had not been removed at an early day.

What has just been said of trees admits of no doubt as regards perennial herbs (plantæ redivivæ) with subterranean creeping stems or stolons. Such plant-stocks as those of the well-known *Paris*, *Anemone nemorosa*, *Convallaria majalis*, *Asperula odorata*, are undoubtedly exposed to none but a casual death.* All plants which renew the cycle of vegetative life repeatedly and without any determinate limits to their existence, and which I would hence call *anabiotic*, cannot therefore be considered *simple* individuals.†

* The same relations of great unlimited age are found in polyps which form stocks. Cf. Ehrenberg: *Abh. d. Acad.* for 1832. p. 382, 420, where among others, stocks of Mæandriæ and Faviæ are referred to, larger than a cord of wood—which may readily be supposed to have been seen by Pharaoh.

† I pass over the further question, intimately connected with this subject, whether the composite plant-stock itself, with all its subordinate generations, with all its possible divisions,—viz., the individual in the most comprehensive sense (in which Gallesio conceived it) has not a determinate term of life, though not easy to be ascertained, on account of the narrow space of time accessible to our direct experience.

At first sight the case seems to be different in the *haplobiotic** plants, which terminate their existence at the end of the simple process of development, with the formation of flowers and fruit; and this they do whether they exist one year, as *Adonis æstivalis* and *autumnalis*, *Nigella*, *Papaver Rhœas*, *Erigeron Canadensis*,† or for two years, as *Oenothera* and *Verbascum*, or for many years,‡ as *Agave* [Century-plant], the East Indian *Corypha*, and the Mexican *Fourcroya*,§ which suddenly puts forth its flowers only after 400 years of extremely slow growth, and ends its life with the formation of its first and long-deferred fruit. The development of these plants, when compared with that of the first mentioned anabiotic plants, seems at first to comprise only *one* generation, and to depend upon the development of *one* individual. But here, too, a closer examination shows conditions incompatible with the nature of the simple plant (the individual). One constituent element in the idea of an individual is, that the parts of the organism are *essentially* connected; yet the stock of annuals themselves presents a multitude of parts which bear no essential relation to the whole plant. This is true of a large part of the ramifications, of branches which may exist in one case and not in others, and

* De Candolle calls *anabiotic* growths *polycarpic* and *haplobiotic growths monocarpic*, terms which are useless from their ambiguity. With an equally inappropriate choice of terms he divides the first (Phys. Veg., II, p. 73) into *caulocarpic* and *rhizocarpic*, according as the stem which produces the fruit is permanent, or dies off down to the root; but the latter in fact never takes place in perennial growths; for in such cases the life of the plant-stock is preserved not by the mere root alone, but by a subterranean portion of the stem. It is one of the most remarkable confusions which a want of true biological ideas has engendered, that De Candolle should have regarded the simplest and most natural circumstance in the plant's life,—its death after having attained the goal of its development,—as an unnatural and to some extent casual occurrence, as a kind of sickness comparable to the succumbing of the mother in childbed, which he accounts for by the rapaciousness of the flowers and seeds. Röper, however, in a note to his translation of the above work, justly remarks that there are annuals with double flowers which die off to the ground although they produce no seeds. We may convince ourselves beyond a doubt that the flowers, on the contrary, are much less rapacious than the vegetative parts of the plant, that they even shut themselves off from the afflux of too copious nourishment; for many plants develop vegetative branches close under the terminal flower, as e. g., *Stellaria media*, *Datura*, *Mirabilis*, etc. In such cases the flower-stalk, which cuts itself off from almost all farther afflux of nourishment, remains slender, while the portions of the stem directly beneath, and the branches which spring from it, gorged with succulent matter, enlarge more and more, and attain a most disproportionate size.

† These plants, like other annuals which germinate in the autumn, are usually reckoned among biennials; but this is a mistake, for like our winter corn they are *plantæ annuæ hiemales*. So, too, many vernal plants, as *Teesdalia*, *Erophila*, *Cardamine hirsuta*, *Spergula Morisonii*, and many weeds of the winter corn, e. g., several species of tares, *Bromus secalinus* et aff.

‡ *Corypha umbraculifera*. Cf. *Rheede*, *Hort. Mal.*, iii, pl. 1–12. This is also the case in the palm-genera *Metroxylon* and *Eugeissona*, according to Martius (*Hist. Palm*, I, p. 108).

§ On *Fourcroya longæva*, cf. Zuccarini in the Nov. act. nat. cur., xvi, 2, p. 666 and pl. 48.

which are proved to be unessential by the plant's losing no essential function when deprived of them. For even when the plant does not produce them, it can fully consummate the object of its individual life; it can produce flowers and fruit. A glance at the examples just now adduced, *Nigella*, *Papaver Rhœas*, *Adonis*, etc., will make these statements obvious. The branches of these plants, each of which, like the stem, is crowned with flowers and fruit, are evidently only *unessential repetitions of the simple plant*, absolutely identical with the main stem, and hence to be ranked as equal to it in importance, i. e., equally to be viewed as particular individuals, and with as much reason as in Zöology we concede individuality to the branches of the coral-stock (polypidom), which are now universally acknowledged to be individuals, and which offer an analogy of decisive importance for ascertaining the nature of the branch in vegetables. In view of this analogy Ehrenberg regarded plants as aggregations of individuals.*

We can now turn back, and apply what has been shown to be the case in the annual herb to the shrub and the tree, each of whose annual generations now appears more distinctly than before to be, in their peculiar connexion, not one individual, but a world of individuals developing in the same period of vegetation and upon the same stem. To this intent many of the early botanists have expressed themselves, as I stated in the Introduction. Thus, B. Batsch, e. g., says of branches, that they shoot forth from the stem "as if they were so many plants rooted in it;"† and Goethe:‡ "lateral branches may be regarded as particular plantlets which are rooted upon the maternal stem, just as this stem is upon the earth." Among moderns, Unger, at the close of his investigations into dicotyledonous stems, says . . "Buds and the branches they develop are individual plants, which live by preying upon the maternal stem."§ Similar expressions are used by Schlei-

* *Abh. d. Akad.*, 1835, p. 247. . . . . "Hence a polyp-stock is a mass of animals. We have no satisfactory comprehensive expression for our idea of a plant. What an individual is remains still unknown; most of them are evidently aggregates of individuals which may be compared with coral-stocks." . . . The origin of coral-stocks is minutely described by Ehrenberg in the Abhandl. for 1832, where he makes the following remarks: "The coral structure is neither a mere structure composed of many animals arbitrarily conjoined, as Ellis supposed; nor one single animal with many heads, or with simple furcations, as Cavolini maintained; nor a vegetable stem with animal flowers, as Linnæus expressed it; it is a body of families, a *living* tree of consanguinity, the single animals belonging to it, and continually developing upon the primary ancestor, are entirely isolated within themselves and capable of complete independence although unable to achieve it."

† *Bot. für Frauenzimmer*, p. 15–16.

‡ *Versuch d. Metam. d. Pfl. zu erklären*, p. 59. The words "just as" in the passage quoted imply too much, and remind us of Du Petit-Thouars' unfounded doctrine of the formation of the woody layers of the stem by the 'roots' of the buds which penetrate it.

§ *Ueber d. Bau u. Wachsthum des Dicotyledonenstammes*, p. 177. Here, too, "preying" is too strong a term.

den;* they are most definite in Röper's works.† Linnæus expressed the same thought in the words "*gemmæ totidem herbæ.*" And I am thus led to make a particular remark, which is intended at the same time to modify in some degree what I said before in relation to the annually renewed generations of trees. It is indeed true that branches of trees and perennial herbs, especially in temperate climates, first appear as buds; and in a more extended sense we call in general every young branch a bud, even if its parts are not, as they usually are, compactly arranged and folded together; still, all buds are not the rudiments of branches. *Lateral* buds are the only ones from which branches originate, and therefore they alone are to be regarded as new lines of development,—as individuals. Terminal buds, on the contrary, are nothing but still undeveloped parts of the (relative) principal axis: they are mere continuations and augmentations of the individual already existing, and are not to be regarded as commencements of a new one.‡ Hence, only those trees which produce no terminal buds, as the Linden, Willow and Elm develop new individuals and nothing else at each renewal of vegetation; while, on the contrary, those which do produce terminal buds also, as for example the Oak and Poplar, bear a mixed annual generation, which consists partly of new individuals, partly of old ones reawakening and continuing their development with renewed vigor.

I have already remarked how unessential the presence of branches is in many plants. A comparison of stocks grown on a rich soil with those of a poor one shows what license is given to plants in regard to producing branches, and how different the appearance of specimens of the same species thus becomes. Plants grown on a poor soil are often called dwarfs; but unjustly, for they present the most normal development of all essential parts, dispensing with everything that is unessential, and are much less

* *Grundz.*, ii, p. 4. "New identical individuals develop upon the maternal stem by continuing the growth," etc. Here the expression "continuing the growth," is improper, for the shoot does not "continue" the growth at all, but is a new growth from a new rudiment.

† "Omnis gemma solitaria aut ejusdem continuatio immediata et perpendicularis (caulis, ramus, ramulus, flos) individuum vegetabile vocatur." This is the most definite description I know of; for in this passage not only the branches so-called, but also every arbitrary shoot, even when it is merely a flower, is acknowledged to be a particular individual. Besides what I have stated in the text in regard to the appearance of terminal buds, I have only to remark, against the word "gemma," that in its growth every shoot does not enjoy a perceptible state of gemmation, i. e., a state of rest in which its parts are folded together. The term bud is applicable to but one state of a shoot or of its parts, and therefore cannot be a suitable expression for what is to be regarded as the vegetable individual.

‡ *Kutzing*, (*Phil. Bot.*, ii, p. 146,) aptly expresses these relations by calling the terminal bud the continuation of the "series of formations," lateral buds beginnings of a new "series of generations." In contradiction with these terms, however, he calls the bud an "organ" as long as it is connected with the natural individual—a term inapplicable to the bud as it is to the developed branch, of which it is the adolescent state.

inclined to malformations than the lusty giants of the rich soils. Not unfrequently we find diminutive speciments of *Erythræa pulchella s. ramosissima* which are branchless and perfectly simple, as they terminate with a flower after four or five pairs of leaves. More vigorous specimens produce two branches out of the axils of the highest pair of leaves, which after a single pair of leaves terminate in the same manner with a flower; and branches of the second order may be also emitted from the axils of the two leaves preceding this flower; and so on. In the first order of ramification the number of flowers amounts to three, in the second to seven, and so on; in the seventh, which is not unfrequently attained, it amounts to 127! Here, if we would consider the stock or specimen as the individual, and the flower as the superior termination of the vegetable organism, comparable, say, to the head of the animal, this variation in the number of the flowers would be as astounding as if we were to learn that an animal might have 3, 7, 15, 31, 73, or 127 heads, according to circumstances. The same thing occurs in *Radiola linoides*. *Erigeron Canadensis*, which often grows to the height of a man and bears as many branches as a tree, presents dwarfed specimens scarcely two inches high and of a perfectly simple form.* After developing two early deciduous cotyledons it presents about 13 leaves on the stem, which are followed by a terminal capitulum of 21 involucral bracts and about 34 flowers. One middle-sized specimen about three feet high presented nearly 100 branches of the first order, out of which branches of the succeeding orders proceeded, together bearing about 2000 heads, and hence (reckoning the head at 34 flowers) 68000 flowers.†

I may here remark, that such unessential branches may be separated and reared independent of their parent stem; on which fact depends propagation by artificial divisions, which is so variously employed in horticulture. The most remarkable case of this artificial division is recorded by Miller: in the year 1766–67, he obtained 500 stocks of winter Rye, by dividing one stock and repeating the operation three times; these 500 stocks emitted 21,109 spikes, bearing together 576,840 grains. Nature herself, as well as art, in various ways may effect such an independent separation of developed branches or of undeveloped buds, and this too either above or beneath the ground. Propagation of the Strawberry by its runners; of the Potatoe and the *Helianthus tuberosus* by their tubers; of bulbous plants by their bulbs; of the

* Not counting the florets, which also are properly so many branches.

† Similar cases occur in most annuals. The forms of *Bromus mollis* and *racemosus* with simple spikelets instead of rich panicles, are well-known; less known and less remarkable are the depauperate specimens of *Umbelliferæ* with one single unifloral umbel, some of which of *Scandix Pecten* are in my possession. I have also specimens of *Solanum nigrum*, one and a half inches high, with a solitary terminal flower.

Garlic by the bulblets formed in the process of flowering, and falling off like seeds; of the varieties of the beautiful *Achimenes* by the amentaceous or the strobiliaceous deciduous shootlets, are well-known examples of this process; and thousands of others might be adduced.*

The gardener can not only separate individuals, but unite them upon one stem. This is true not only of individuals of the same species, but even of those of different species; sometimes even of different genera of the same family. The Lilac is not unfrequently grafted upon the Privet (*Ligustrum*), the Pear upon the Mountain Ash (*Sorbus Aucuparia*), the Peach upon the Almond. By the insertion of a bud (inoculation), or of a developed sproulet (grafting), we are thus enabled to pluck different kinds of roses from the same bush, to gather different kinds of fruit from the same tree. It would evidently be a contradiction in this case to consider the whole tree, or the whole bush, as the individual; for we should then give the name to a compound of several species, or even of several genera.

In attempting to comprehend the vegetable individual in its simplest form, we have thus far spoken of unessential branches only, and have endeavored to show that they cannot be regarded as mere parts of the individual. But there is another kind of branches, those which are essentially requisite for the attainment of the end of vegetation,—for the formation of flowers and fruit. These occur in all plants which possess no terminal buds, and which must hence necessarily have some branches in order to attain the end of their existence. This is the case with the Evening-Primrose, Larkspur, *Orchideæ*, etc., whose lateral flowers are just such essential branches. If we demand that the individual should be a complete representative of the characters of the species, as is implied in the usual view, then we must add to the principal axis such branches as these,—without which the process of vegetation is not concluded, and on which, in fact, the most essential and characteristic parts of the plant make their appear-

* I will only adduce a few more of these examples, which might be multiplied indefinitely. Besides the Garlic (*Allium sativum*) in many other species of *Allium*, e. g., *A. oleraceum, carinatum, vineale*; *Lilium bulbiferum, tigrinum, humile*, and other species, *Gagea fistulosa, Ficaria ranunculoides, Dentaria bulbifera, Saxifraga bulbifera* and *cernua, Cicuta bulbifera, Polygonum viviparum, Begonia bulbifera, diversifolia* and other species, *Remusatia vivipara, Cystopteris bulbifera*—buds fall off above the ground (as bulblets). In *Stratiotes aloides* rosette-like developed axillary shoots separate close to the base. The separation of lateral shoots in *Lemna* is well-known; and it occurs in a similar manner in *Pistia*, by the separation of thin-stalked lateral rosettes, and in *Hydrocharis* in the separation of peculiar winter buds. When the inferior leaf-formation is gorged with sap, bulblet-like buds form from the axils of the root-leaves (frondes fundi) in *Saxifraga granulata* and many exotic species of *Oxalis*, in the same way as the bulb-brood of monocotyledonous bulbous plants. Inferior leaf buds which are placed on the ends of their stolons become free by the death of the runners in *Epilobium palustre, Lycopus Virginicus*, etc., and swell out and form little lumps. Cf. on this subject Wydler (Flora, 1853, p. 17—24).

ance,—and call these parts of the same individual. In this sense Schleiden's view of the simple plant might perhaps be justified, although, as he starts from different premises, he does not consider mere floral branches as particular individuals. He says: "If nothing but organs of reproduction, or flowers, spring from the bud we still call the plant a simple one."*

Here, however, we arrive at a contradiction, which shows us that we cannot carry out the idea of the vegetable individual with the requisite definiteness in this way, since we thus regard essentially similar branches, now as individuals in themselves, now as mere parts of individuals. As I have already remarked, Schleiden allows individual importance to branches which are identical† with the main axis; those on the contrary which produce flowers alone, and in this respect differ from the main axis, he regards as mere parts of the simple individual. This distinction when analyzed is perfectly nugatory; since it only lays down two extremes, between which there are an infinite number of gradations. Strictly speaking, there are no branches which are perfectly identical with the main stem, as is evident from the fact that no branch begins with cotyledons, as the main axis does.‡ Besides, the foliaceous leaves on the branch are almost always fewer than those on the main axis, and generally fewer in proportion as the point is higher where the branch originates. The arrangement of the leaves on the branches, also, often differs from the arrangement on the main axis, as e. g., in most of our broad-leaved trees, —in the Elm, Hazle, Chestnut, Linden, etc., in which the phyllotaxis on the main axis, and often at a later period in the so-called "water-shoots" (Wasserschossen), is spiral or decussate, while on the branches, it is, on the contrary, distichous. In *Alnus viridis* the phyllotaxis is tristichous on the main axis, and distichous on the branches. On the main axis of Cypresses and *Thuja* there are 3–4-leaved whorls; on the branches the pairs of leaves are nearly decussate; this is also the case in *Lysimachia vulgaris*. In the same way in *Equisetum* the number of the rameal verticillate leaves is always inferior to that of the cauline ones. While thus on the one hand the vegetative branches are nowhere entirely similar to the stem from which they spring, on the other hand it appears that those branchlets which seem to bear flowers only are usually more numerous than they seem to be; since in most cases one, two, or even more small leaves (bractlets), are present beneath the flower, which may easily escape notice on account of their diminutive size, although their existence may

* *Grundz.*, ii, p. 4. † *Grundz.*, ii, p. 4.

‡ The basillary cotyledons of the branches, indeed, have been compared to cotyledons. This comparison is partly justified in view of the commencement of phyllotaxis on the branch; which often resembles that on the main axis, whilein regard to form and consistency almost all resemblance disappears.

be often ascertained with certainty even in those cases in which they are not visible when the flower has reached its complete development.* If we are to deny individuality to those buds (branches) only which are composed of a flower alone, as a strict interpretation of Schleiden's language demands, we should have to draw a most unnatural and often impracticable line of demarcation between branches which, physiologically speaking, are perfectly homologous (floral branchlets which really have no bracts), and those which bear imperceptible or even suppressed (abortive) bracts. If on the other hand we would reckon the latter also among the branches which are not individuals, then it may be contended that there is such a series of gradations in regard to number and vigor in the leaves which precede the rameal flower, that it is impossible to draw a dividing line even in this manner.

The above-mentioned distinction between unessential and essential branches seems to afford a better stopping-place, no matter

* In fact, all the constant lateral flowers of *Primulaceæ*, *Cruciferæ*, *Capparideæ*, *Resedaceæ*, *Balsamineæ*, *Orchideæ*, never have any bractlets. Among monocotyledonous plants in many cases there is only one bractlet; among the dicotyledonous there are generally two. *Gesneriaceæ* have generally three; *Empetrum* and *Santalum* have four, *Eriostemon* five, *Polemoniaceæ*, *Cuscuteæ* and other plants with paniculed inflorescence an indeterminate number. We possess the following means of showing the existence of suppressed bractlets: 1. The position of the parts of the flower relatively to the axis of origination from which the lateral flowers spring. 2. Analogy. 3. The study of malformations. 4. Observations of the flower's development. The first criterion can be applied only where we can determine the succession of the parts of the flower. The position of the parts of a lateral flower depends in fact upon determinate laws of rameal origination; when they do not harmonize with these laws we must conclude that preceding leaves have been suppressed. In this way, e. g., we can explain the very common position in the 2-5th arrangement of the calyx with the second sepal posterior, by supposing two bractlets according to the fixed law, while it cannot be explained without these bractlets. Analogy aids us most by confirming our conclusions, as e. g., in the families *Scrophularineæ*, *Labiateæ*, etc., in which many genera present distinct bractlets, while others appear to be without them. In monstrous flowers (in cases of *antholysis* and *chlorysis*), sometimes without any other malformation, bractlets otherwise imperceptible appear in an abnormal growth. Not unfrequently in *Digitalis purpurea*, which in its normal state presents no bractlets, but in which we inferred their original existence from æstivation and the position of the calyx relatively to the axis, I have found bractlets developed in the most heteregeneous degrees, especially on the lowest flowers of the raceme of cultivated specimens. C. Schimper and myself have both observed the same fact in *Tropæolum majus*, which, like most species of this genus, presents no trace of bractlets in the normal state. We have seen them in the form of very small, white, subulate leaves about in the middle of the flower-stalk, while the flower remained unchanged in all other respects. Their existence, however, was already indicated by the position of the quincuncial calyx relatively to the axis, as well as confirmed by analogy, for *Tropæolum ciliatum* R. et. P. (Pöpp. et Endl. Nov. Gen. t. 38) in its normal development has two round and prettily ciliated bractlets on the the flower-stalk. I have mentioned the history of development last, not to disparage study, but because the morphology must be rightly understood beforehand by means of comparisons of developed structures, and because in its present stage the development is incapable of giving us reliable information in regard to all the leaves which are present in the germ, though they may not develop. To know what parts then exist we should have to be able to distinguish the leaf as a cell or a group of cells before it rises to view above the surface of the stem.

whether the branch bears nothing but a flower or not. We might say, all essential branches must be regarded as individuals since they repeat the process of specific development laterally, and can become independent plants, as layers, whether natural or artificial. Those branches, on the contrary, which appear as necessary members in the line of development which is advancing towards flower and fruit, and which therefore complete the series of formations belonging to the species, and without which the plant is either unable to eke out its vegetable life or to accomplish propagation, must be regarded as members of one and the same history of development. Let us take a case where the main stem bears only proper leaves, branches of the first order only bracts, and those of the second order only flowers and fruit, as is really the case in *Plantago*, *Melilotus*, *Veronica officinalis* and *Chamædrys*; here it is evident that these three divisions cannot be isolated; that all three must necessarily be present in order that the specific life may attain a complete representation in one individual.*

Notwithstanding the importance of this discrimination between essential and unessential branches, it cannot, when analyzed, establish a distinction which will enable us to decide upon their importance as individuals; for even those branches which appear unessential, in relation to the formation of flowers and fruit, may yet be essential to the plant in other relations: as when they appear as characteristic elements of the vegetable structure, or when they play any important part in the economy of the plant, as I have shown *in extenso* elsewhere.† Nay, more; one and the same branch, as to whose nature there seems to be no doubt, may appear either as essential or as unessential, according to circumstances. When those branches which conduct the structure to a higher stage of its development appear in great numbers on a principal axis, as e. g., in indefinite racemose or spicate inflorescence, the lateral branchlets appearing as flowers are then indeed, generally speaking, necessary to the plant's full completion of the series of formations, and in this sense essential; but their number is immaterial as regards this completion; and this the plant itself shows in producing either a larger or a smaller number of them; sometimes the number is reduced to one.‡ Therefore, properly speaking, only *one* lateral flower is essential; and we may arbitrarily consider any one of the number to be this essential one. Hence each of them may be regarded indifferently as essential or unessential. This is not the case in those racemes and spikes which possess a terminal flower, as is the case in many

* [But why assume (as here and *supra*) that the species must attain a complete representation in a single individual in vegetables?—since this is by no means the case in the higher (unisexual) animals, where there is no doubt as to what corporeally constitutes the individual,—that is, in the very cases whence we derive our idea of individuality, and the standard of comparison which our author is endeavoring to apply to the case of plants. A. G.]

† v. Verjüngung, p. 41, et. seq.

‡ E. g. not unfrequently in the raceme of *Lathyrus odoratus*.

Campanulacæ, e. g. in *Campanula rapunculoides*. Here all the lateral flowers are unessential: yet if the terminal flower is cut off, the lateral branchlets which bear the flowers at once become essential. Such a change is not always artificial, for it often happens naturally, as there are plants in which the terminal flower may be either present or absent. *Agrimonia Eupatoria*, and *Campanula rapunculoides*, are examples of this variability.*

We can cut this Gordian knot only by deciding to consider every branch as an individual, however appearances may be against it, provided that we have other grounds sufficient to regard branches as individuals. The genesis of branches justifies us in so doing; for each branch is not a direct continuation laterally, is not a development belonging to the stem (like the leaf), but is a new formation; like the main axis itself, it has its own centre of formation, with its peculiar development. Branch and stem, main axis and lateral axis, differ therefore only in their origin and relative position; but they are essentially of the same nature; they are united in the idea of the *shoot*. The stem is the primary and principal shoot of the whole plant, the branch is a lateral shoot in reference to the main shoot; but it can itself become a relatively main shoot, and the stem of a succeeding generation of shoots in its turn. As far, then, as we are justified in speaking of vegetable individuality at all, we must hold fast to the individuality of the shoot: *the shoot is the morphological vegetable individual;* is that form or that part of its specific realization which is analogous to the animal individual, if any part is.

In zöology we give the name of individual to every whole which is controlled and bound together from one vital centre. Since such an internal domination of the organism as that which characterises animal life is wanting in plants, whose existence is a process of growth directed externally alone, we can only demand, as the criterion of vegetable individuality, that the individual shall be formed in direct continued development from one centre, and thus in accordance with its origin, *shall, in all its parts, belong to one centre.* Now this is the character of the shoot. Its centre of formation has been known since C. F. Wolff's celebrated "Theoria Generationis" (1759) under the name of "*punctum vegetationis;*" it is about what is called in

* *Agrimonia Eupatoria* bears usually one spike without any terminal flower; in weak specimens, a terminal flower not unfrequently makes its appearance which opens before the upper lateral flowers. This has been observed by Wydler (Bot. Zeit. 1844, p. 642). In *Campanula rapunculoides* the case is just the contrary: its looser spikes are usually terminated with a flower, while denser ones end in a coma of bracteal leaves, without any terminal flower. *Dictamnus* resembles *Agrimonia;* while *Triglochin* (especially *Tr. maritimum*) on the other hand imitates *Campanula*. Even in plants in which the essentiality of the lateral position of the flower is expressed by their zygomorphic development, terminal flowers make their appearance in some cases; they then resemble *Peloriæ*. This is the case in *Linaria*, *Orobanche*, and a *Digitalis purpurea monstrosa* (described by Vrolik, Flora, 1844, No. 1), which propagates by seeds, and is now widely disseminated in our gardens.

common life the "heart," of the plant, or, at the first appearance of the lateral shoot, the "eye." The whole future of the plant slumbers unseen within it; leaf after leaf arises out of it, step by step, at a measured pace, prescribed by law, until (in case the shoot is destined to conduct the development thus far) the series concludes with the last formation, that of the carpels, which close over the dying point of vegetation and form the fruit. In this progress the centre, always keeping the lead, is ever advancing, rising more and more, and leaving behind it an axis arrayed with the organs already formed. Hence we may designate the vegetable individual as *the sum of the parts belonging to one axis.* Just as the body of the animal has only one trunk and one head, the shoot has but one axis and one apex. As the trunk of the animal has a second extremity opposite to the terminating head, and gradually dwindling down till it forms the tail, so the perfect shoot has a second extremity opposite to that which terminates with the most perfect structure (the fruit), and dwindling down to an indeterminate end, the root, by means of a *punctum vegetationis* turned downward.*

But it will be objected: is not the vegetable shoot indefinitely divisible, can we not cut it up into an arbitrary number of pieces, each of which is capable of reproducing the whole plant in its turn? Were this the case the phenomenon would not be without its parallel among the lower animals. But this is not the case. The supposed divisibility of the vegetable shoot, at least in perfect plants (the Phanerogamia) to which I am now alluding, is a delusion, which rests simply upon the fact that the formation of new shoots has been confounded with a reproduction of the shoot as such. As the injured shoot has the faculty of producing new shoots, so the parts of the divided shoot have also this faculty in many cases; but this is no re-completion of the shoot itself; the fragment of the old shoot can continue to develop in one single case only: when, in fact, it bears the apex of the axis with the point of vegetation. Let us examine this case more closely. If a shoot is divided transversely, under certain circumstances the upper part, on which the *punctum vegetationis* ("the heart") is

* Aristotle, on the contrary, considered that the root, being the imbibing organ, was the part of the plant which corresponds to the upper part, to the head and mouth of the animal; and he regarded the stem as the inferior part. He found the cause of this topsy-turvy position of plants in the necessity under which they labor of drawing their nourishment from the earth, as they are incapable of moving from place to place. In this respect he compares plants to muscles (ὀστρακόδερμα), which also have their heads turned downwards. Cf. *Wimmer: Phyt. Aris. Frag.* 56–65. This comparison of the root with the animal's head is however, morphologically speaking, inverted; for as the highest stratum of the spinal chord (the sensorial portion) attains its maximum state of development in the head of animals, it can only be compared to that extremity of the plant's axis in which the highest and noblest part of the plant is exhibited. Besides, the peculiar and striking characteristic of the animal's head, its involved structure terminating the organism, is by no means to be found in the root end of the plant; but it is seen in the opposite end which terminates with flower and fruit.

still remaining, may continue the development; but the lower part is nothing but a stump, and continues to be a stump which can never complete itself by a terminal shoot, and which never fails to die if it is not nourished by lateral sprouts formed before, or sometimes after, the division took place, and thus kept alive by its posterity. This cannot be called divisibility, in the usual meaning of the term; the whole phenomenon, on the contrary, strongly reminds us of the capacity animals possess of losing the less essential caudal extremity without any cessation of life. In favor of this view the fact may be adduced that a similar phenomenon occurs in the normal process of development of plants and animals. As there are animals which may spontaneously lose the posterior extremity of their body during the course of their development, as e. g., *Cercaria*, *Comatula*, frogs, etc., so there are also numerous plants in which the posterior extremity gradually dies off, and is cast aside, during the course of growth, while the anterior end of the shoot, which bears the *punctum vegetationis* continues to unfold; as is seen in the growth of many mosses, especially of Peat-mosses, in the creeping and climbing rootstocks of Ferns and *Aroideæ*, in the long creeping stems of *Lysimachia nummularia*, the little subterranean creeping rootstocks of *Paris*, in most plants which possess a *radix præmorsa*, as e. g., *Succisa pratensis*, the perennial species of *Plantago*, in *Tormentilla*, etc., with which the perennial bulbs of monocotyledonous plants agree in all essential respects; and finally, this is especially remarkable in *Utricularia*, and in *Selaginella increscentifolia*, whose apices only form close buds, and last through the winter, while all the remaining parts of the shoots perish. If the shoot is indivisible transversely, it is still less so longitudinally. There is not a single case to prove that a shoot longitudinally divided can as such continue to develop; nor do we know of a single case where such a longitudinal division takes place spontaneously. What has been usually described as a bifurcation of the stalk depends in the Phanerogamia in every case upon a true ramification which takes its rise laterally close under the apex, as I have already described it in the case of *Erythræa pulchella*. As a *normal* formation no immediate division of the stalk occurs among Phanerogamia; for the phenomenon known as "fasciation," which might be adduced here, is always a monstrosity.* The stalk, or axis of the shoot, is hence indivisible in

* Fasciation depends upon a real division of the punctum vegetationis into two parts of equal importance; in the simplest case it produces a simple division into two parts. Here neither of the two parts can be regarded as a branch of the other. If repeated bifurcations follow each other in the same plane, and in unbroken connexion the well known "ribbon and fan" like forms arise which however usually end at last in single apices. Very rarely more than two parts lying in different planes are produced by the division of the *punctum vegetationis*, a case which I have noticed in the capitula of Compositæ. The rarest phenomenon which bears upon our subject is the annular fasciation, in which an annular border arises from the simple point of vegetation, of which I shall speak more at large in the following Part, when

the higher plants, in the same sense that the body of the higher animals is indivisible.* The only phenomenon which might be described as a division of the stalk is leaf-formation. This, however, is not a division into new stalks, but a formation of subordinate parts belonging essentially to the stalk, as it were an eradiation of the stalk itself, which may be aptly compared to the formation of the extremities in the animal body. We may therefore justly describe the shoot, or the vegetable individual, as an indivisible axis,—as an axis with its appertinent radii which are inseparable from, and regularly arranged by, its own development. With the first appearance of the branch a new axis is formed, and a new system of subordinate radii appears. However completely the branch may contrive to interweave itself with the trunk during the course of its development, it always owes its origin to an accessory point of vegetation which develops into a particular axis. The vegetable individual thus presents in its nature a certain analogy to the mineral individual,—the crystal,—as well as to the animal individual; for the crystal is determined by the relation of its parts to one and the same system of axes. As soon as this system of axes holds another position there results another individual, which may be distinguished even when two or more individual crystals intersect, so as to form twin crystals, or stellate crystals.

In the preceding considerations on the indivisibility of the axis I described the leaves as its radiations,—as members of the stalk, and belonging essentially to it,—and I attempted to distinguish the leaves from the branches, by considering the latter as new axes. But how are leaves and branches distinguished in their genesis? Are not the branches as much radiations or lateral members of the stalk as the leaves? It would lead me too far from my subject to make a fundamental critical investigation into this question, and to examine the existing views of the mode of formation of leaves and branches, especially as investigations into this subject have not been complete enough to enable us to obtain reliable results. I can therefore only allow myself a few hints in this place. The leaf originates in the earliest period of the formation of the stalk; and its rudiment is contemporaneous with the first stages of the formation of tissue in the *punctum*

I compare the relations of growth in the Cryptogamia. A division of the individual corresponding to fasciation in phanerogams and to dicthotomy, its homologue, in many cryptogams also occurs in the animal kingdom, as appears especially in many genera of corals, e. g. *Caryophyllæa* whose stocks are formed in this manner exclusively, and in *Astræa* and *Faviæ* in which it appears in conjunction with shoot-formation (gemmation), as was shown by Ehrenberg, (Beiträge, etc., Abh. der Acad., 1832, p. 242). Ehrenberg explains the form of *Dædalineæ* as a result of incomplete termination of the individuals in gemmation; in appearance it resembles the coxcomb-like forms of fasciation as they occur in a remarkable way in some monstrous *Cacti* of the genera *Mammillaria* and *Echinocactus*, as well as in *Celosia cristata*, well-known as an ornamental plant.

* [Some criticisms upon this may be given at the close of the whole memoir. A. G.]

vegetationis. A leaf can never be formed at a later period from the developed axis. It is a necessary consequence of the manner in which the leaf originates, that an absolute dividing line cannot be drawn between leaf and axis; for the subsequent position of the leaves upon the organism affords no standard of appreciation, especially as most of them do not mark the basis of the leaf, which loses itself in the axis. Earlier, before the extension of the axis begins, the rudiments of the leaves are always closely pressed together, so that they appear as a peripherical development of the axis itself, occupying the whole upper surface, and dividing it into clearly defined planes, which may be recognised even in the developed state, in those plants whose foliaceous *pulvini* are distinctly marked, as e. g. in many Ferns, most acerose plants, in Cacti, and particularly in *Nymphæa* and *Victoria* where the *pulvini* may be distinguished even in the interior of the axis. The primitive vascular system of the axis enters directly into the leaves, and ramifies there; while the woody layers of the stem, which are found later, have no connexion with the leaves. With branches the case is totally different. In their origin and development they always succeed the leaves; and even at a much later period, when the leaves have been long cast off, shoots may originate in places where, at an earlier period, no trace of a rameal rudiment, or of an eye, was to be found. If we now consider the axillary shoots,—i. e. those branches whose position is predetermined by the situation of the leaves,—at an early period we shall find their rudiments, even though they develop very late or not at all, in the form of a circular and slightly prominent gibbosity, which may be compared with the apex of the axis; or rather, it is an accessory *punctum vegetationis* forming near the apex. The circumstance of the epidermis of the axillary shoot's being a continuation of that of the stem, is explained by the early date at which it originates; for this takes place at a time when the surface of the axis has not yet lost its flexibility. The eye is shown to be an independent centre of vegetation by its subsequent internal and external conformation; for it not only develops leaves upon its surface, and this too with an independent commencement of its phyllotaxis, but even in its interior the first system of vascular fibres seems to be formed independently of that of the main axis; as originally it lies upon it, and afterwards becomes intimately blended with it by later layers of tissue. Notwithstanding the intimacy with which later formations of woody tissue unite branch and stem, still, according to Unger's investigations, no immediate influence is exerted by the branch upon the conformation of the stem, since the stem owes none of its essential parts to the branches.* This independence of the branches is shown still more decisively in adventitious shoots, whose posi-

* *Unger: Ueber den Bau des Dicotyledonen-Stammes* (1840), p. 65, *et* 66.

tion is not predetermined by the leaves. Originating at a later period, they take their rise not from the surface but from the cambium layer,—the internal tissue which preserves the faculty of producing new growths. Hence if they would come to the light of day they must break through the bark. Their origin has been particularly described by Trécul.* W. Hofmeister, however, as I have already remarked, succeeded in tracing it in *Equisetum* back to the first cell, a cell in the interior of the stem. As is the case with axillary buds, such adventitious buds sometimes remain undeveloped for a long time (ten years and more) without losing their vital activity; a fact to which attention has lately been called by C. Schimper,† in a report on exostoses. When this is the case they not unfrequently develop into spherical or conical wood-kernels, which continue to exist without any connexion with the ligneous body of the maternal stem; this is especially the case in Beeches and Poplars.

The individual nature of the shoot is confirmed not only by the mode, but by the place, of its origin. While the organs of the individual organism,—the leaves of the plant,—occupy a position determined with geometrical accuracy, shoots on the contrary can arise out of almost any part of the plant, wherever indeed any cambium exists; and they may be even enticed by art out of places where they do not usually appear. There are shoots from the *stem*, the *root* and the *leaves*. In herbaceous stems they appear in situations determined by the leaves (in the axils of the leaves), while they may be found anywhere on old woody stems‡ as adventitious buds, or on any part of the lignified roots of most dicotyledonous woody growths, and even on some monocotyledonous ones, as in *umbraculiferæ*.§ Shoots appear less frequently on the roots of herbaceous plants.‖ Shoot-formation from leaves has often been discussed and described in regard to many plants, especially *Bryophyllum*, *Cardamine pratensis*, *Drosera*, *Malaxis paludosa*, etc. A fine example of this is shown by a *Chelidonium majus var. laciniatum* reared by Bernhardi in the Botanical Garden at Erfurt, from whose leaves

* *Trécul: Recherches sur l'orig. des bourg. adv.* Ann. des sc. nat., viii, (1847) p. 268.

† In Sept., 1852, in the Versammlung der Naturforscher in Wiesbaden.

‡ Rarely scattered shoots appear on the herbaceous stem, and especially on the first internode under the cotyledons, as Röper (Enum. Euphorb. 1824) first showed in *Euphorbia*, and Bernhardi in the germ of *Linaria*. A specimen of *Begonia manicata, dipetala* cultivated in our [Berlin] Botanical Garden, which is probably the same species as the *B. phyllomaniaca* of Martius, presents the case of a plant which produces a multitude of shootlets in the whole leaf-region; they arise from the sappy stem which is not yet hardened, soon after the fall of the leaves.

§ According to Rheede, *Corypha umbraculifera* sends forth root-shoots when the stem dies off after the fruit has ripened.

‖ I have often observed them in *Linaria vulgaris, Helichrysum arenarium, Rumex Acetosella, Ajuga Genevensis, Jurinea Pollichii, Nasturtium sylvestre* et *Pyrenaicum*. According to Wydler, they often appear in *Viola sylvatica*.

floral bractlets arose, partly unifloral, partly multifloral, without any preceding leaves.* Shoots may be allured by the gardener out of most leaves which do not wither too soon.† Finally, the little budlets in whose bosom the germ of the new plant is formed and developed, and which we call seeds, are a kind of shoots, which in most cases owe their origin to leaves, (carpels) out of which they spring (on the margins, which unite to form the placenta) or more rarely, out of their whole inner surface.

(To be concluded in our next number.)

Art. XVIII.—*On Different Centers of Primitive Civilization;* by Thomas H. McLeod.

We have already called attention in a previous number of the Journal of Science‡ to the radical difference of the Indian, Grecian and Roman Systems of Numerical Notation. We would again refer to those several Systems, and in addition, to the Egyptian, Mexican and Chinese, in reference to different centers of primitive civilization.

It will be remembered that the Indian System commences with a 0 (zero), and is made up of principal and subordinate measures, and has its origin probably in land or lineal measuring; that the Grecian System is a system of principal and subordinate measures also, but has no 0 (zero), its first figure being a *unit*, making use of mere characters to express its large measures, and has its origin in the contemplation of individual objects; that the Roman System also has no 0 (zero), its first character being a *unit*, and is rather a system of fives than of tens, introducing a new character (V) for that number, one for ten (X), which may be regarded as a double V, one for fifty (L), one for one hundred (C), one for five hundred (D), and one for one thousand (M), expressing the intermediate numbers by repetitions and combinations. The Egyptian System commences with a *unit* which it represents by a single downward stroke, adding an additional stroke for each successive number to ten which it denotes by a triangular figure (△); this figure is repeated for each successive ten to one hundred. The scheme will be seen by the following representation:

I, II, III, IIII, IIIII, IIIIII, IIIIIII, IIIIIIII, $\overset{10}{\triangle}$, $\overset{20}{\triangle\triangle}$, $\overset{30}{\triangle\triangle\triangle}$, $\overset{40}{\triangle\triangle\triangle\triangle}$, &c.

* I may add to the examples I have given of shoot-formation taking place out of the leaves, one which I observed in June, 1853, in *Levisticum officinale*. I found, in fact, in several species of this Umbellifera, one or more, frequently two, shoots in the points of division of the leaves, which after producing a few weak leaves bore a small umbel. (Later note.)

† *Kirschleger* (Flora 1844, No. 2) notices a fine example of this in *Gloxinia speciosa*.

‡ Journal of Science for January, 1855, Art. vii.

"The Aztecs expressed the digit *one* by a small circle, thus, O. Months were expressed by a peculiar symbolic figure for each, taken from natural or artificial objects. Duplications and combinations of the circle were made adjacent to the symbol so that the day of the month was exactly denoted. These were also the formulas for other transactions."* The Chinese System consists of thirteen distinct characters and is a system of juxtapositions. The *unit*, which is the first figure in the system placed adjacent to a certain character denotes one hundred, two units placed with this character denotes two hundred, &c.

From this statement it is manifest *first*, that, the Indian, Chinese, Egyptian, Mexican, and probably the first system of the Greeks are radically different and primitive; *secondly*, that, the Roman System and the second system of the Greeks, which is similar to the Roman, is a simplification of, and derived from, the Egyptian; and *thirdly*, that these several systems originated in the very earliest periods of the human race before the several stocks of these nations had made any advancement in common, in civilization, and after they had separated from each other, for they could not have advanced far in the cultivation of the arts and sciences without a method of numerical notation,—not even from the savage state; for the savages of North America were beginning to form a rude system, when they were first known to the Europeans, so that it may be justly inferred that the several nations with whom the several systems of notation above alluded to were formed, separated before they had advanced in civilization beyond the North American Indians. Consequently there must have been several points on the earth distant from each other, where the mental energies of man were developed and primitive civilization began. These points, as evinced by the above facts, were probably, the East Indies, Egypt, possibly Greece, Mexico and Central America, and China.

ART. XIX.—*Additional Note on Arachis hypogæa;* by GEORGE BENTHAM, Esq.†

IN the year 1838 a short paper of mine was read before the Linnæan Society on the structure and affinities of the *Arachis*, in which I pointed out the curiously imperfect achlamydeous female flowers from which the fruits are produced, whilst the apparently perfect hermaphrodite flowers are, generally speaking, if not always, barren, and I showed a closely similar structure and fructification in *Stylosanthes*, next to which I proposed to place *Arachis* among *Hedysareæ*. This paper was published in the eighteenth volume of the "Linnæan Transactions," a work

* Extract from a private letter from Hon. H. R. Schoolcraft.

† From Hooker's Journal of Botany, No. 77, 177.

which is unfortunately far too expensive and bulky to have any circulation among foreign botanists. The conclusions I had come to became known to them only by abstracts contained in botanical journals or other compilations, unaccompanied by the observations from whence they had been deduced; and my proposal for associating *Arachis* with *Hedysareæ* has been more than once treated as absurd, without however any facts or arguments being brought forward in opposition. Recently again a writer in "Silliman's American Journal," Mr. Hugh M. Neisler, whose article is reproduced in the last number of "Taylor's Annals of Natural History," adduces some observations of his own in support of a denial of the existence of the two kinds of flowers in *Arachis*, although he also had not seen my paper, the details of which would probably have led him to perceive his mistake. At the time I wrote it I had only had dried specimens to examine, but these were numerous and good, belonging to several species of *Arachis*, and to about twenty species or marked varieties of *Stylosanthes*. I have since then repeatedly examined dried specimens of both these genera, as well as of *Chapmannia*, and have observed *Arachis hypogæa* in a living state, especially in the summer of 1853, when I had the opportunity, in the Botanic Garden at Leipzig, of rooting up and carefully examining several plants of that species, bearing a profusion of flowers of both kinds, in various stages of development. These flowers always appear several together, in short, close spikes, in the axillæ of the leaves. In the upper axillæ, the barren but apparently perfect flowers are the most numerous; but even these are generally accompanied by one or more of the minute fertile ones, and the latter, which are always without calyx or corolla, become more numerous in the lower axillæ. The withered perfect flowers remain long sticking about the spike, and may sometimes be found apparently adhering to (but not connected with) the point of the fertilized ovary of the female flower, and borne along with it as its stipes lengthens, as mentioned by Mr. Neisler; but I always find within the tube of these withered flowers their own dried up, barren ovary, with its unfertilized ovules, and if Mr. Neisler will compare these barren ovaries with those of the female flowers before the stipes has lengthened above a line or two, he will find the latter very different in shape, smaller in size, with a small sessile stigmate, wholly incompatible with the supposition of its ever having borne the long filiform style of the barren ones. The presence of imperfect flowers, deprived of corolla and even of calyx, but more prone to form their seed than the more showy and perfect ones on the same plant, is a phenomenon of not unfrequent occurrence among *Leguminosæ*, especially in several genera of *Phaseoleæ* and *Hedysareæ*, and has also been observed in other Natural Orders, such as *Cistineæ*, *Violaceæ*, *Malpighiaceæ*, etc.

ART. XX.—*Observations on Binocular Vision;* by Professor WILLIAM B. ROGERS.

PART SECOND.

Conditions under which two or more right lines are optically united.

IN what precedes I have pointed out the unusual combination of visual adjustments by which from two separate drawings we form a simple binocular resultant, and I have shewn that this is not confined to experiments like those with the sliding-stage apparatus, but occurs, although to a less extent in the use of the common stereoscopes. The observations which I am about to describe have been made chiefly with the former instrument because of the facility it affords for multiplying and varying the experiments and because after a little practice it enables us to obtain the resultant figure as clearly and perfectly as the best stereoscope of Wheatstone's or Brewster's construction.

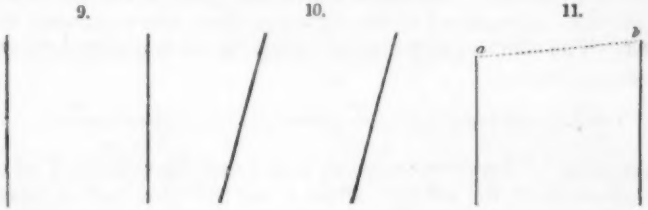
The purpose of these observations has been chiefly to acquire clearer ideas in regard to two important questions in binocular vision which have been ably investigated by Wheatstone and Brewster and on which they have published differing views. The first of these relates to the *process of forming the binocular resultant*, which, according to Brewster, always involves the successive combination of pairs of corresponding points in the two drawings, but according to Wheatstone, is simultaneous throughout at least a large part of the figure. The second question refers to the binocular *combination of unequal drawings* first described by Prof. Wheatstone, but the reality of which Sir D. Brewster has attempted to disprove by experiment.

In these enquiries I have begun with the most simple combinations and have thence proceeded to less obvious ones, endeavoring at each stage to repeat and vary the observations of the distinguished observers above named, and to reach some satisfactory conclusion where they differ from one another as to the fact or the interpretation. While these enquiries have in many respects satisfied me of the correctness of the views of these philosophers, they have led me to regard in a different and somewhat new aspect certain parts of the process of binocular vision involved in the questions above alluded to.

6. *Of the combination of parallel right lines either vertical or oblique.*

Two equal parallels (fig. 9 or fig. 10), when placed on the upper stage of the stereoscope may be united in a position farther from the eyes than their true place, or when adjusted on the

lower stage may be combined in a position nearer than their true place, and in either case the resultant is a single line parallel to the components and including them co-extensively throughout its whole length.



Unequal parallels (fig. 11) may also be united into a parallel resultant, but in this case the component lines are not co-extensive throughout the resultant. By marking their extremities with dots or short lines we can observe the limits of each, and we then perceive that as long as the eyes and the diagram preserve their relative position unchanged, the two lines are not coincident, even when they are very nearly of the same length. But by turning the head or the diagram so as to rotate the plane of the optic axes in relation to the figure, we may cause either the upper or the lower ends of the parallels to coincide according to the direction of the movement. When the upper ends are thus brought together the lower ones are seen to recede from one another; when the lower ends are made to coincide the upper ones separate to their greatest distance—the interval in both cases being marked by the dots on the resultant. The dotted line (fig. 11), shews the direction parallel to which the line joining the two eyes must be placed in order by a due convergence of the optic axes to unite the points *a* and *b*, and the angle made by this line with the horizontal measures the angular movement of the head or the diagram necessary to bring about the coincidence.

When the parallels are nearly coincident, the adjusting motion of the head is so slight as to be made almost unconsciously. This movement is, I think, one of the causes of the apparent union of unequal figures described by Prof. Wheatstone, and in that connection will be referred to in a subsequent page.

7. *Vertical rotation of the eyes associated with their converging movement.*

My experiments with unequal parallel lines have led me to observe effects accompanying the convergence of the axes to points either beyond or within the limits of distinct vision which indicate a rotation of the eyes in opposite vertical directions. As similar phenomena are noticed by a friend whom I have induced to repeat the experiments, I infer that they do not arise from any ab-

normal adjustment of my own eyes, and I therefore deem them worthy of mention in this place.

In attempting to unite unequal parallel lines by converging the axes beyond the plane of the diagram, I find it easier to bring about the terminal coincidence above described, when the lower of the dots is presented to the right eye than when opposite the other. The effect is very obvious when fig. 12 is adjusted on the

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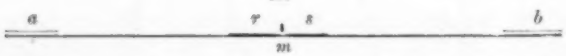

upper stage of the stereoscope, so that *a* and the right half of *m* are presented to the left eye, while *b* and the other half of *m* are opposite the right eye. Fixing the long line in a horizontal position in the plane of the optic axes, I cause *a* and *s* to approach, and in doing so I find that they either unite at once, or are readily brought together without shifting the head or paper. But when I make the same effort with *b* and *r*, I can only bring the latter below the former, and find it requisite to turn slightly the head or the diagram in order to unite them. It would therefore seem, that when converged beyond the limit of distinct vision, my eyes tend to revolve vertically in special directions, the right eye turning very slightly downwards and the left upwards.

When I direct my eyes to a point much nearer than the limit of distinct vision the evidence of vertical rotation in connexion with the converging movement is very remarkable. To observe this I adjust the lower and upper stages of the apparatus to the distance of 12 and 7 inches respectively and placing (fig. 13) on

13

the lower stage in such position as by cross vision to present *b* and *c* to the right eye and *a* to the left, I converge the axes a little below the aperture. As the two parts of the figure approach one another, I see *a* and *b* coming nearer to the same horizontal level and when the due convergence of the axes is attained I observe them to coalesce completely. But retaining the figure and the head in the same position, I find it impossible to bring about a union of *a* and *c*. In order to do this I must either turn my head so as to depress the left eye below the level of the other, or I must turn the diagram in the opposite direction. When this latter motion is used to produce the coincidence of *a* and *c*, I find on subsequently inspecting the figure that I have been compelled to depress *a* considerably below the level of *c*.

A like effect appears when I view (fig. 14) as in the preceding experiment. In this case *a* and *b* instead of combining takes the

positions shown in (fig. 15), where the line presented to the left eye appears in a higher position than that presented to the right, although when directly looked at they are seen to be on the same level. By inclining the diagram so that *a* (fig. 14) shall be lower

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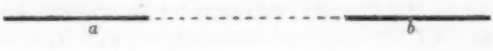

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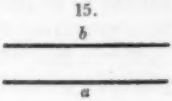

than *b*, the resultant parallels (fig. 15), approach one another, and when the proper inclination is attained, (in this particular case about eight degrees,) the two lines unite to form a single inclined resultant.

The following experiment, very easily repeated is one of many of the same kind which I have made to test the peculiar adjustment of my eyes when strongly converged. Placing myself in a seat about 15 feet from a window, with my eyes on a level with one of the horizontal bars, I direct my view to the end of a pencil or other small object held before me at the distance of distinct vision. I then observe whether the two images of the horizontal bar form one line, and if they do not, I adjust the position of my head until I find them entirely free from vertical displacement. Without moving my head I now converge the optic axes to some point much nearer than the pencil, and I see the two images of the horizontal bar at different levels, the right image being lower than the other.

In all these cases of convergence to a point nearer than the limit of distinct vision the effect is obviously such as would arise from a rotation of the right eye in an upward and of the left eye in a downward direction. It thus appears that in converging my eyes towards a point beyond the limit of distinct vision, there occurs a very slight displacement of the two images in opposite vertical directions, indicating a motion of the left eye upwards and of the right eye downwards, and that in converging them to a point nearer than the same limit a much greater displacement occurs corresponding to a much more considerable rotation of the eyes in the reverse directions.

In referring the various effects above described to an opposite vertical rotation of my eyes, I would not have it understood that I regard such rotation as absolutely demonstrated in these cases. The same displacements might perhaps be explained by changes in the shape of the eyes due to muscular tension, but the rotary movement seems to furnish a much simpler and more probable explanation.

8. *Combination of pairs of vertical lines.*

If two pairs of equidistant and equal vertical lines (fig. 16) be placed on either stage of the stereoscope so that *a* and *b* shall be

presented to one eye and *c* and *d* to the other, it is easy by a proper convergence of the axes to unite *a* with *c* and *b* with *d*. The two resultant lines will of course be vertical and will be in a plane parallel to that of the diagram, and they will be situated behind or in front of it according as the union has been effected by converging the eyes beyond the diagram or before it.

When the intervals of the vertical lines forming the respective pairs are unequal (fig. 17), the union of *a* with *b* and of *c* with *d*

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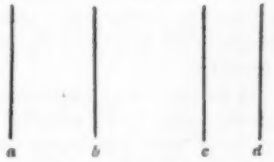

forms two resultant verticals which lie at different distances before or behind the plane of the drawing. Supposing the union in the present case to be effected behind that plane, the resultant of *a c* will be more remote than that of *b d*. If the combination is produced in front of that plane, the resultant of *a c* will be nearer to us than that of *b d*.

When the intervals between the verticals are nearly equal, the change of convergency requisite in passing from one resultant to the other is so quickly brought about that we can scarcely perceive that the two resultants are not seen each in perfect singleness at the same moment. If however the difference be great, as when *a b* is one inch and *c d* half an inch, although we can readily unite *a* with *c* and *b* with *d*, a considerable effort is necessary in passing from the one convergency to the other. Hence as soon as we form a distinct single resultant of *a c*, that of *b d* becomes double, and when again *b d* are united into one line the resultant of *a c* becomes double. The same effect occurs when the inequidistant vertical lines form parts of any of the twin drawings of a more complex kind which are usually provided for stereoscopes, as will be pointed out under a subsequent head.

9. *The two parallel resultants are formed at the same time.*

It is important to remark that when the pairs of parallels are equidistant, the two resultants are *simultaneously* formed, and do not require the eyes to be directed to them successively. This is proved by the fact that, however intently we fix the view on one of them, the other appears clearly visible as a single line, and when the attention is directed to a point between the two, the singleness of each is perfectly preserved.

Sir D. Brewster, in one of his valuable papers on binocular vision, maintains that in order to see an object distinctly the optic

axes must be successively conveyed on every point of it. In the case of objects having relief, and in that of the perspective figures of the stereoscope, I am convinced that this process is, to a certain extent, necessary. But the observations above cited show that the principle of successive vision does not apply in the case of parallel resultant lines in a plane at right angles to the direction of view, or in that of actual lines or points situated in that plane; it being understood in both cases that the objects are near enough to the optic axes to be distinctly visible. In a more recent paper, (Phil. Mag., May, 1847,) the same eminent observer appears to admit the latter view; for, in his beautiful observations on the binocular combination of the series of plane figures upon carpets and paper-hangings, he says: "these figures being always at equal distances from each other and almost perfectly equal and similar, the coalescence of any pair of them, by directing the optic axes to a point between the paper-hangings and the eye, is *accompanied by the coalescence of every other pair.*"

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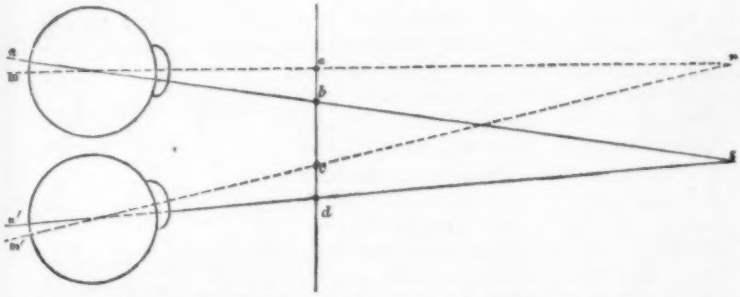

The conditions of this simultaneous binocular union are illustrated in (fig. 18), where *a* . . *b* and *c* . . . *d* represent the two pairs of equi-distant points, or parallels. Here *a* and *c* are united at *r*, the point to which the optic axes are supposed to be conveyed, and at the same time *b* and *d* are combined at *s*. As *a b* and *c d* are equal, *n* and *n'* are practically at equal distances from the retinal centers *m* and *m'*, on the same side, the normals to the surface at these points, marking the directions in which *b* and *d* are perceived, form at the resultant *s* an angle equal to that at *r*, and hence *r* and *s*, the two resultants, are practically at equal distances from *a d*, or from the line joining the centres of the two eyes.

10. *Conditions of vision of a physical line in a vertical position.*

When a straight wire, or other physical line, is held in a vertical position before the eyes, the visual conditions under which it is

seen as a single line are very simple. The optic axes being converged to one point of it, the images of the point formed in the two eyes are referred to the point itself, and as the same convergence serves a like purpose for the pairs of images corresponding to other parts of the line, the union of the two images of the line is *simultaneous* throughout so much of the length as is distinctly visible. When the line is of considerable length, a sensible change of convergence is necessary in tracing it upwards or downwards, and in these directions it assumes the character of a perspective line, the visual conditions of which will be referred to hereafter. Thus the *optical signs of a vertical line are uniform convergence of the optic axes and a simultaneous and perfect union of the two images of the line.* It is obvious that the same characters belong to all short lines situated in a plane perpendicular to the plane of the optic axes. But lines oblique to this plane, or in other words, perspective lines, are seen under very different visual conditions, the consideration of which belongs to the following section.

(B) 11. *Of the binocular union of mutually inclined lines.*

If we place on the upper stage of the stereoscope a card on which are drawn two lines converging upwards at a small angle (fig. 19), so that *a c* may be presented to the left eye and *b d* to the right, and if we unite them by converging the axes beyond the card, they will form in that position a resultant line in a *perspective* attitude receding as it extends downwards. Inverting the diagram but retaining it on the upper stage, we may by a like effort of convergence obtain a perspective resultant corresponding with the other in place and length, but having the reverse attitude, that is receding in the upward direction.

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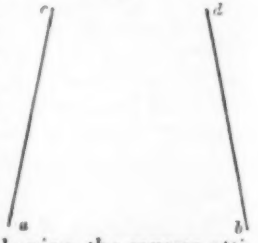


If now we place the card on the lower stage and combine the lines *a c* . . *b d* by cross vision in front of the figure, we obtain a perspective resultant which when the component lines converge upwards recedes in the upward direction, and when these lines are reversed recedes as it extends downwards.

It is scarcely necessary to remark that in all these experiments the *perspective attitude* of the resultant is a simple consequence of the unequal intervals between the corresponding parts of the component lines, requiring various degrees of optical convergence to effect their union. Thus in the first experiment the upper end of the resultant, formed by the union of *a* and *c*, will be situated behind the diagram at the point of convergence of the visual lines passing through these points from the left and right eye respectively, and the lower end of the resultant will be placed at the

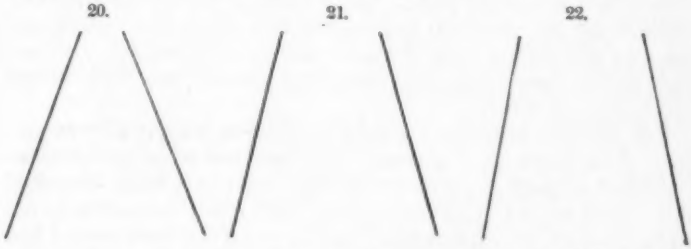
point of convergence of similar lines, extended through *b* and *d*. Hence the lower end of the resultant will be at a greater distance than the upper end; and for a similar reason, the intermediate pairs of points in the component lines will be united at various intermediate distances, and thus the resultant will appear as a perspective line receding as it extends downwards. A like explanation obviously applies to the other cases above described.

Such is a general account of the formation of the perspective resultant by the union of inclined lines. But there are features in this phenomenon which from their bearing on the theory of binocular combination are deserving of a more minute and varied examination. As a first step towards this the following experiments are of interest as showing the chief conditions in the formation of the perspective resultant and illustrating the different degrees of completeness of the effect.

12. *Comparative results with lines differently inclined.*

Diagrams well suited for this comparison are represented in figs. 20, 21, and 22, in each of which the lines are separated be-

20. 21. 22.



low by an interval of $1\frac{1}{4}$ inch and have a vertical height of the same amount. The inclination of the lines in fig. 20 is 40°, and in the others 30°, 20°, and 10° respectively. Confining my remarks in the first place to the effects observed when the upper stage of the stereoscope is used and the binocular union is produced beyond the diagram, I begin with fig. 20, the lines of which make an angle of 40°.

Having placed the figure properly on the stage, I first adjust the visual convergence so as to bring together the upper ends of the lines, and maintaining this convergence, steadily I see the two lines combined into the figure of an inverted $\vee$. I then by a change of convergence unite the two lower ends and retaining the adjustment I observe them to form a $\vee$ in the erect position. In the same way by intermediate degrees of convergence I can cause the lines to appear as crossing one another at the middle or any other point of their length. But in either of these phases of combination it is to be noted, that *so long as the inclination of the optic axes proper to it is maintained without change, the resulting figure presents no appearance of relief*, but contin-

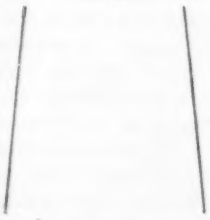
ues in the plane of the paper, or more properly in a parallel plane behind that in which the diagram is actually placed.

If now by suffering the eyes to range up and down along the resultant I combine the corresponding points in somewhat quick succession, I observe the various phases above mentioned to follow one another rapidly and at the same time I see the component lines assuming in part or wholly, the appearance of intersecting lines *in relief*. This effect, however, recurs only *transiently*, and as we observe it, the lines again subside into the plane parallel to the diagram. Owing to the great inclination of the lines in this figure, it is difficult to vary the convergence of the lines fast enough to unite the corresponding points in such quick succession as to bring about the perspective effect.

This is more readily done with fig. 21, whose lines are inclined at an angle of 30°. On first viewing these lines placed on the upper stage, I sometimes see a resultant consisting of intersecting lines without relief, and sometimes one consisting of intersecting perspective lines which on fixing the optic axes more steadily subside to the parallel plane. It is easy by giving the eyes free range along the resultant to continue this perspective effect, and again by compelling them to a slow change of convergence, to produce all the phases of intersection in the parallel plane without any appearance of relief.

Fig. 22 viewed under the same conditions, almost always presents the appearance of intersecting perspective lines, unless a special effort is made to preserve the optic axes in a fixed direction. But in this, as in the preceding case, such effect never fails to destroy the relief, which however, returns when the eyes are left free to their natural fluctuations of convergence. In viewing this figure it occasionally happens that the two perspective lines for a part of their length appear to be melted into one. Such is the result whenever their corresponding points have been united in very quick succession, in other words, when the eyes in rapidly glancing along a part of the figure have been carried through the necessary gradations of convergence.

23.



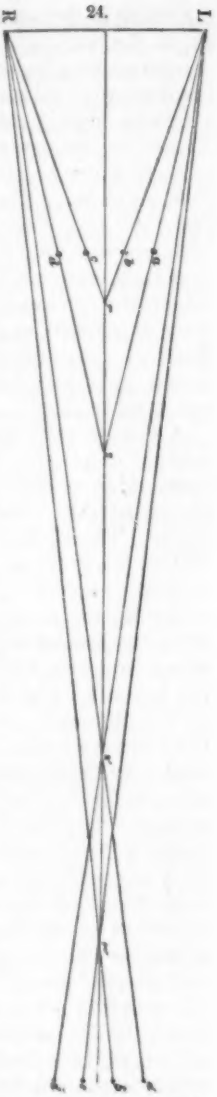
With fig. 23, the lines of which have an inclination of only 10°, the appearance of the resultant is sometimes that of a single perspective line and sometimes that of two such lines intersecting but very close to one another. It is important to remark that the latter effect always presents itself when we endeavor to fix the convergency of the axes, and that when we succeed in maintaining this direction, even for a few moments, the perspective lines, as in the preceding cases, lose their relief and present themselves in some phase of intersection in the parallel plane.

Owing to the small inclination of the lines in figure 23, a very slight fluctuation of convergence is sufficient to effect the successive union of many corresponding points, and this taking place involuntarily and almost instantaneously, gives us the perspective single or double resultant as the first or natural binocular effect. The effort necessary to prevent this slight and spontaneous fluctuation of convergence is such that unpractised observers find it difficult to bring the intersecting lines into the parallel plane. On first view they are apt to regard the result as a single perspective line, and it is only through a close and more deliberate inspection that they discover the two nearly coalescing intersecting lines of which the perspective figure consists. It is however, easy after some experience in these experiments, to maintain such perfect fixity of convergence at different stages of the binocular combination, as to give the resultant the form of intersecting lines in the parallel plane.

A similar gradation of effects is presented when the figures just referred to are placed on the lower stage of the stereoscope in the same order as before, but with this general difference that each corresponds in result to lines of less inclination on the upper stage. Thus I find that fig. 20 combined by cross vision in front of the lower stage, presents appearances like those above described in fig. 21; and so fig. 21 gives the perspective lines proper to fig. 22 on the upper stage, while this latter on the lower stage gives the almost single perspective line of 23 in the upper. In this comparison the upper stage is supposed to be 15 inches and the lower 31 inches from the rear end of the instrument.

This different grade of effect with the same figures, according as the lines are combined in front or behind their actual position, is evidently dependent on the much greater range of axial rotation required in the former than in the latter case in order to combine successively given parts or the whole of the inclined lines. Thus in fig. 24, if L and R denote the centres of the left and right eyes respectively, *a d* the lower and *b c* the upper ends of the lines placed on the upper stage, and *a′ d′* and *b′ c′* the same points of the figure as placed on the lower stage, it is obvious that *a* and *d* will be binocularly united at *s* and *b* and *c* at *r*; also that *a′* and *d′* will be combined at *s′* and *b′* and *c′* at *r′*. In passing from the union of *a* and *d* to that of *b* and *c*, that is in combining successively all the corresponding points of the two lines, the optic axes must be turned through the angles *a* L *b* and *d* L *c*, respectively, making a total change of convergence equal to 2 *a* L *b*. In combining successively all parts of the same lines placed at *a′ d′* the whole change of convergence is 2 *a′* L *b′*, an angle less than the preceding nearly in the ratio of the distances of the lower and upper stages from the centre of the eyes. This comparatively small variation of convergence in the case of a given

pair of inclined lines on the lower stage brings them into the same relation to the converging movement of the axes as a pair of lines less inclined to one another placed on the upper stage.



From a comparison of the results above described we may I think, draw the following conclusions:

First. The eyes are disposed naturally or from habit to incessant slight changes of convergence which are effected unconsciously and with great celerity. Hence the continuance of any given state of convergence implies a constrained state of vision and requires a special effort of will.

Second. Great variations of convergence require a sensible and even considerable time, and are not spontaneous, but the result of voluntary effort.

Third. The successive union of corresponding points belonging to lines slightly inclined to one another, is effected almost instantaneously and without conscious effort. That of such points in lines having a much greater inclination is effected slowly and by a voluntary exertion.

Fourth. In the binocular combination of two mutually inclined lines no perspective effect is produced so long as the convergence of the optical axes is kept unchanged.

Fifth. The apparent relief or perspectiveness of the resultant presents itself only where contiguous corresponding points of the two lines are combined in rapid succession. Hence it never occurs when the lines are greatly inclined to one another, and it always shows itself in greater or less extent when their inclination is so small as to require an inconsiderable change of convergence.

Sixth. This perspectiveness is seen as well when the resultant is obviously composed of two intersecting lines, as when it appears as a single line, and it is destroyed whenever by voluntary exertion we suspend the usual or spontaneous changes of convergence.

In referring the perspectiveness of the resultant line or lines to the rapidly successive union of corresponding points, I would not

be understood as assuming that all the points of the component lines must be thus successively combined. It will hereafter, I think, be shown that this is neither necessary nor of usual occurrence. But I wish to give prominence to the fact that such a union of corresponding points through some portion perhaps or very small part of the two lines is requisite to the formation of a perspective resultant. This view differing almost equally from that of Sir D. Brewster and Prof. Wheatstone, will be considered in more detail under a future head.

The involuntary and rapid changes of axial convergence within certain small limits, which as we have seen, forms an interesting feature in such observations, does not seem hitherto to have attracted special attention; and the fact that *the resultant has a perspective position even when the lines forming it cross one another at a considerable angle*, has not I believe been referred to by previous observers, although as will hereafter appear, it has an important bearing on the theory of binocular perpective.

13. *Review of some experiments of Prof. Wheatstone bearing on the doctrine of successive vision.*

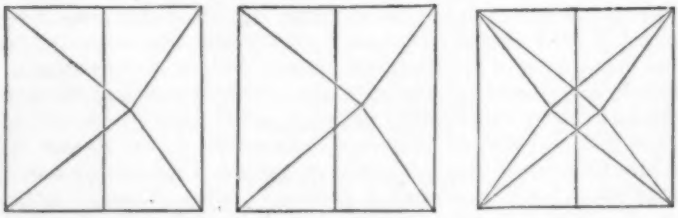
In commenting upon the doctrine of successive vision by points, Prof. Wheatstone remarks, that were this entirely true "no appearance of relief should present itself when the eyes remain intently fixed on one point of a binocular image in the stereoscope. But in performing the experiment carefully, it will be found that provided the pictures do not extend too far beyond the centres of distinct vision that the image is still seen single and in relief when this condition is fulfilled," (Phil. Trans.: 1838). The result here described is obviously at variance with the statements above made in regard to the resultant of two inclined lines viewed under a fixed convergence of the axes. But without in the slightest degree doubting the general accuracy and the great ingenuity of Prof. Wheatstone's observations, I am compelled in the present instance to dissent from his description of the phenomena. In multiplied trials with his reflecting stereoscope and the refracting one of Sir D. Brewster, as well as with my own apparatus, in the course of which I have submitted to examination most of the linear diagrams commonly used, I have invariably found that by converging the axes steadily on one point of the image the lines situated laterally near but behind or before it in the perspective, are made to appear *double*, and that by continuing the same fixed convergence these lines are made to *lose their relief* and to take their places in a plane at the same distance as the point to which the eyes are directed.

These effects are most striking in the case of figures having considerable depth of perspective and in which the lines and angles of the posterior surface are nearly covered by those of the anterior, as in binocular drawings of polyhedral crystals. Con-

verging my eyes fixedly to the near apex of such a figure I see the remote one double and the oblique edges diverging from it also double; and in the same manner I find it easy to double every one of the angles or edges by fixing the eyes on the angle or edge lying in the same direction of view on the opposite side of the figure. When the image is a truncated square pyramid with its plane of truncation nearest the eyes, by looking intently on one of the vertical sides of the base I see the corresponding side of the smaller square double, or by fixing my eyes upon the latter I see the former double. In any of these cases a continuance of the same convergence causes the angles and lines in question to appear in the same plane.

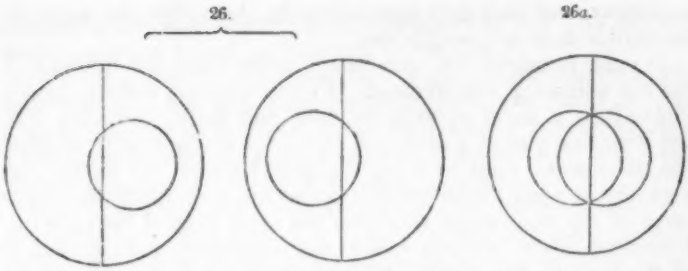
Among the figures suited to illustrate this effect I have found none to present more striking results than the square pyramid or the truncated cone, with the addition in each case of a vertical line drawn through the centre of the base. The twin drawings adapted to produce these forms are represented in figs. 25 and 26.

25. 25a.



If, after obtaining the perspective resultant of fig. 25, I look intently on the apex of the pyramid so as to see it at a single point, I at the same time perceive the transverse line in the base as two parallel lines, and if I direct my view to the base so as to see this line as single, the apex is doubled and each of the oblique edges of the pyramid is converted into two lines diverging from an angle of the base. By continuing the same degree of convergence the image loses its relief and presents the appearance of fig. 25*a*, in which all the lines lie in one plane. Here the convergence being just adapted to the union of the two squares produces an effect equivalent to the superposition of the one plane figure on the other.

In the case of the truncated cone (fig. 26), on directing the axes to the vertical line in the base so as to see it distinctly single, the small end appears as two intersecting circles; fixing the view on the centre of the small end the vertical line in the base becomes double, and the large circle appears indistinctly as two intersecting circles. In either case a fixed convergence destroys



the relief of the image. When this is done by fixing the view on the base, the resultant is the plane figure represented in fig. 26*a*, in the other case the figure is the converse of this.

It may be added that among the linear drawings commonly used with the stereoscope there are some in which these effects are less observable than in the above instances, and others in which the attempt to obtain a clear view of either the nearer or remoter lines of the perspective is attended with a painful degree of confusion. As this arises from the doubling of points or lines situated before or behind the point to which the axes are converged, it may be laid down as a rule in the selection of such figures for the stereoscope that *the most satisfactory drawings are those in which there is no anterior line crossing a posterior one and in which when two such lines are parallel they are not situated in or near the same vertical plane of view.*

As a very different degree of convergence is required for uniting the lines proper to the near side of the perspective image from that necessary for the remote side, more or less time must be consumed in passing from the one to the other. Hence in many cases even the most practised observer is unable to make this transition with sufficient celerity to have a clear perspective impression of the whole, and to this cause is no doubt due in part, the difficulty experienced by most persons unused to the stereoscope, in embracing distinctly the form and relief of the entire image.

Prof. Wheatstone cites "as equally decisive against this theory" of successive vision, the experiment of combining two inclined lines by converging the axes to a point nearer than the paper (Phil. Trans., 1838, or Phil. Mag., 1852). He says, "look intently on the upper end of the resultant line without allowing the eyes to wander from it for a moment. The entire wire will appear single and in its proper relief, and a pin or a piece of straight wire may without the least difficulty be made to coincide exactly in position with it." Of the precise visible coincidence between the resultant figure and the wire properly placed in this experiment there can be no question; but the important feature as I conceive in this phenomena is, that *it is only under particular*

conditions, and then only approximately, that either the image or the wire is seen as a single line.

In order to repeat the experiment under various conditions, I use the following arrangement. Fixing a strong sewing needle midway in a small cylinder of cork and firmly fastening into the cork one end of a thin stiff wire or knitting needle, so that the two needles shall be at right angles, I secure the former immovably in a horizontal position across the opening of the upper stage of my stereoscope very near the inner edge of the opening. I can then adjust the long wire to any inclination, and the friction of the cork on the horizontal needle will retain the wire in its position.

Taking fig. 21 or 22 as the subject of experiment, I place the drawing on the farther stage and move the other back or forward until a notch in the near end of the wire is brought to coincide precisely with the point of binocular union of the two lower ends of the component lines. I now unite the two upper ends of the lines by a due change of convergence, and depress the free extremity of the wire until the resultant point just mentioned coincides with this end or with some other point of the wire. When this is done, the wire is adjusted to coincidence with the perspective image. By sliding the stage a little nearer, we may see the image just behind the wire, and by moving it the opposite way it will appear on the near side of the wire. Whether coincident or in either of these positions, *both the image and the wire will appear as two perspective lines intersecting at the point on which the eyes are for the moment fixed.*

By continuing the same convergence, we cause the wire as well as the coincident image to subside from the perspective position, and we see them each resolved into two intersecting lines in a plane parallel to that of the diagram. Fixing the eyes on the near end of the wire or of the binocular resultant, they each appear in the plane in the form of a $\vee$; gazing intently on the remote end they present themselves as a $\vee$ inverted. If we direct our eyes intently on the plane of the paper we see the wire as two black wires covering or adjoining the inclined lines of the diagram.

With lines less inclined, as in fig. 23, we obtain similar effects; but as might be inferred from what precedes, whether we regard the wire or the coincident image, the divergency of the intersecting perspective lines is less remarkable than in the preceding cases, and a more perfect and continued fixity of axial direction is requisite to destroy their relief.

A very interesting effect is observed when the diagram is so placed on the farther stage that the wire after being adjusted as above, leaves uncovered a portion of each of the inclined lines. In this case the perspective figure is composed partly of the re-

sultant of the uncovered portions and partly of the wire, *the former appearing as the continuation of the latter.*

We may I think conclude from these experiments that the coincidence of the wire with the resultant of the inclined lines, instead of proving this resultant to be impressed on the eyes as a single line, merely shows that *in respect to relief* both it and the wire are viewed under the same visual conditions.

It is to be remarked that for these experiments the lines of the diagram ought to be as slender as is consistent with great distinctness and the wire as thin as it can be made without a loss of rigidity. When the lines are broad or the wire thick there is an appearance of singleness near the point of intersection due to the overlapping of the two images which in the case of slightly inclined lines may extend through much or all of their length.

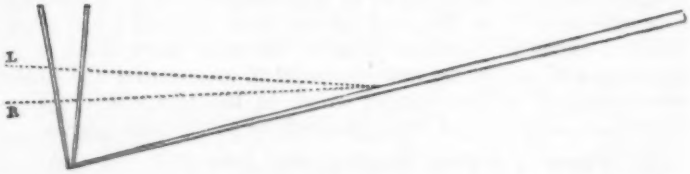
14. *Tapering form of the perspective resultant.*

In repeating these experiments it will be observed that while the wire coinciding with the perspective resultant appears of unchanging thickness throughout its whole length, this resultant seems to increase slightly in diameter from the near to the remote end. The cause of this difference although obvious, is not unworthy of remark. In the case of the wire the retinal picture in each eye is of course wider for the near than for the remote end, and would if uncorrected, convey the impression of an object tapering towards the farther extremity. But the different distances at which through varying convergence and other adjustments we see the different parts of the wire, serve to rectify this impression, and under the perception we obtain that of an object of uniform thickness throughout. In the case of the perspective image, on the other hand, the retinal picture in each eye is of uniform breadth, because the lines of the diagram are so and are practically in every part of their length at the same distance from the eyes. Thus the diameter of the resultant disc or lines actually subtends the same angle in both eyes for every part of the length. But in virtue of its perpective position, its different parts seem to be placed at different distances. Hence the diameter of any part of the resultant must appear greater in proportion to the distance at which it seems to be placed, and it will appear to grow broader as it is traced from the near to the remote end.

The effect here described is scarcely appreciable with most of the stereoscopic drawings, owing to the small range of distance through which the perspective extends. By using two inclined lines each three or four inches long and combining them when placed on the upper stage of the stereoscope I obtain a resultant whose remote end is more than twice as distant as the near one, and in this case the enlargement towards the farther extremity is very obvious.

A simple mode of obtaining the same effect in a yet more manifest degree is the following. Adjust two slender cylindrical rods six or seven inches long, so that, while they nearly touch at one end, they spread apart about an inch at the other. Hold them before the eyes R, L, at the distance of distinct vision in a vertical plane transverse to the line of view and with the angle downward (fig. 26). Then form the binocular resultant by directing

27.



the axes beyond them with varying convergence. This resultant stretching away from the angle obliquely towards the wall will be seen to increase in diameter regularly from its near to its remote end.

From these facts it may be inferred that in order with the stereoscope to obtain a perspective figure, all the lines of which shall be of precisely equal thickness compared with one another, and each of them of the same thickness at every point, it would be necessary so to construct the drawings that the breadth of the corresponding parts of the component lines should be proportioned inversely to the distances at which they are to be united.

(*To be continued.*)

ART. XXI.—*On the identity of Sanguinarine and Chelerithrine, and on the direct determination of Nitrogen;* by Dr. JAMES SCHIEL of St. Louis, Mo.

I HAVE used a small portion of hydrochlorate of Chelerithrine which I received in 1843 from my friend, Prof. H. Will of Giessen, and which the discoverer of that alcaloid had prepared himself, to make a few analytical experiments as to its composition.

As the salt was not found to be free from impurities, it was dissolved in water, precipitated by ammonia, washed, dried, dissolved in ether, the filtered solution treated with animal charcoal, and the chelerithrine precipitated with a solution of pure sulphuric acid in ether; the sulphate of chelerithrine was washed with ether, dried and dissolved in water, when it yielded with ammonia a precipitate of pure Chelerithrine, which absolutely showed the same properties and behavior as Sanguinarine.

Of the pure substance dried at 105° C.,

0·356 grammes burned with oxyd of copper and oxygen, furnished 0·918 carbonic acid = 70·34 per ct. of carbon and 0·167 water = 5·21 per ct. of hydrogen.

The direct determination of nitrogen gave 5·07 per ct.

0·3925 gramm. of the double salt of the hydrochlorate of chelerithrine and chlorid of platinum yielded 0·707 of platinum: thence the atomic weight = 341·74.

Accordingly the composition of Chelerithrine is:

Carbon, - - - -	70·34
Hydrogen, - - - -	5·21
Nitrogen, - - - -	5·07
Oxygen, - - - -	19·38
	100·00

The composition of Sanguinarine I found:*

Carbon,	70·03	69·82	70·02
Hydrogen,	5·27	5·08	5·14
Nitrogen,	5·23		
Oxygen,	19·14		
	100·00		

The atomic weight was found in three determinations 322·7; 362·7; 346·4, or taking the mean =343·9.

From all this it appears that Chelerithrine and Sanguinarine are one and the same substance corresponding to the formula $C_{38}H_{16}NO_8$. This formula gives:

Carbon, - - - -	70·80
Hydrogen, - - -	4·97
Nitrogen, - - - -	4·35
Oxygen, - - - -	19·88
	100·00

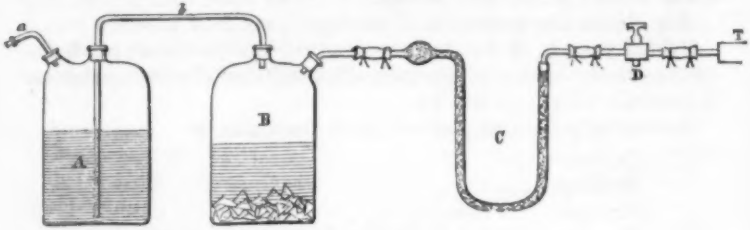
It will be perceived that the above formula includes one equivalent of carbon more than the one I formerly deduced from the analysis of Sanguinarine.

For the preparation of one or the other of these alcaloids the following method is the simplest and cheapest.

Digest the root of the plant Sanguinaria Canadensis (or Chelidonium majus) with water strongly acidulated with sulphuric acid and precipitate with ammonia, wash and dry the precipitate, dissolve in ether, and treat with animal charcoal. After filtration the alcaloid is precipitated with a solution of pure sulphuric acid in ether. It is pure sulphate of sanguinarine.

* Annalen d. Chemie und Pharmacie by Liebig and Wöhler, B. XLIII, p. 233.

For the determination of nitrogen I do not use the bicarbonate of soda but the following apparatus, from which a current of carbonic acid is passed through the combustion tube.



A is a Woulfe's bottle containing diluted muriatic acid.
B, a similar bottle with pieces of chalk and water.
C, Chlorid of calcium tube, part of it filled with chalk; a piece or two of pumice stone separates the two substances.
T, Combustion tube.

Condensing the air in bottle A by blowing through the mouth-piece *a*, some of the acid passes into B and sets carbonic acid free, which passing through A washes the atmospheric air contained in B mostly out, then close the mouth-piece with a cork and open the little stop-cock D. When a part of the gas passing through the combustion tube is entirely absorbed by the chalk, the stop-cock D is closed, the cork taken out from the mouth-piece, and the combustion is performed in the common way. After the combustion, another current is passed through the combustion tube by opening the stop-cock and closing the mouth-piece, having previously driven some acid into B. In case of need the stop-cock could be omitted, but the little expense hardly justifies such a simplification.

ART. XXII.—*On an apparent Perturbation of the Law of Definite Proportions observed in the Compounds of Zinc and Antimony*; by JOSIAH P. COOKE, JR., Cambridge.*—With a plate.

IN a former paper in this Journal† I described two new compounds of zinc and antimony $Sb\,Zn_3$ and $Sb\,Zn_2$ which I named respectively, Stibiotrizincyle and Stibiobizincyle, because they resemble in their composition the metallic radicals of organic chemistry, and because the first decomposes water rapidly at 100° C. I there stated that crystals of $Sb\,Zn_3$ could be obtained containing a much larger amount of zinc than that required by the law

* Abstract from a Memoir of the American Academy, New Series, vol. v, p. 337.
† This Journal, vol. xviii, p. 234.

of definite proportions, and that this change was not accompanied by any alteration of crystalline form. A similar variation of composition was afterwards observed in the crystals of $SbZn_2$, and it is the object of the present paper to describe the law of the variation in both cases and to explain its cause.

In the course of my investigations on this subject, crystallizations were made or attempted of alloys differing in composition by one half to five per cent., according to circumstances, from the alloy containing 95 per cent. of zinc to that containing 95 per cent. of antimony; but only two crystalline forms were observed, that of $SbZn_3$ and that of $SbZn_2$. Well defined crystals, like those described under $SbZn_2$ in the former paper,* were obtained from the alloys between 43 and 60 per cent. of zinc; and even in alloys of a higher zinc per-centage, crystals of the same form were still seen, although they were no longer well defined. In the alloys between 20 and 33 per cent. of zinc, well defined crystals, like those described under $SbZn_3$ in the same paper, were formed; and finally there separated from the alloys between 33 and 42 per cent. of zinc thin metallic plates, which evidently belonged to the same crystalline form. In making the alloys from 43 to 95 per cent. of zinc, the zinc was melted first, and when in fusion the antimony was added. As the melting point of antimony is much above that of zinc, the fluid zinc acted on the solid antimony as a solvent, dissolving the pure metal, but not the impurities, which rose to the surface forming a scum. This scum seemed to take with it some of the antimony and thus caused a loss, which, together with the impurity, was found by experiment to be about three per cent. of the antimony used. This resulted in raising the per-centage of zinc in the alloy at most about eight-tenths of one per cent. The alloys below 43 per cent. of zinc were made by melting the antimony first, and then adding zinc. By this method the loss of antimony was very greatly diminished, and, counting the impurity, was found to be only about one per cent. and a half of the antimony used. In preparing the alloys this loss was always allowed for, and the crystallizations were all made as nearly as possible under the same circumstances, so that any unexpected cause of error should affect all equally. The crystals formed in the alloys were all analyzed in my laboratory under my direction and immediate supervision, and the greater part of them by myself. The rest were by my assistants, Mr. F. H. Storer, Mr. C. W. Eliot, and Mr. C. S. Homer, to whose care and accuracy I take pleasure in bearing witness. Their work is in all respects as reliable as my own. The results are collected in the following table which will explain itself.

* This Journal, vol. xviii, p. 234.

Analyses of the Crystals formed in the Alloys of Zinc and Antimony.

STIBIOTRIZINCYLE.						STIBIOBIZINCYLE.					
Composition of the Alloys by Synthesis.		Composition of the Crystals by Analysis.			Name of the Analyst.	Composition of the Alloys by Synthesis.		Composition of the Crystals by Analysis.			Name of the Analyst.
Per ct. of Zn.	Per ct. of Sb.	Per ct. of Zn.	Per ct. of Sb.	Sum.		Per ct. of Zn.	Per ct. of Sb.	Per ct. of Zn.	Per ct. of Sb.	Sum.	
70·40	29·60	64·15	35·77	99·92	Cooke.	33·00	67·00	35·37	64·57	99·94	Cooke.
66·50	33·50	61·00	39·00	*100·00	Cooke.	do.	do.	35·40	64·60	†100·00	Cooke.
64·50	35·50	53·50	41·44	99·94	Cooke.	32·50	67·50	34·62	64·92	99·54	Storer
. .	. .	55·49	44·42	99·91	Homer.	do.	do.	34·61	65·39	†100·00	Eliot.
60·60	39·40	55·00	45·09	100·09	Homer.	31·50	68·50	33·95	66·09	100·04	Storer.
58·60	41·40	50·39	49·29	99·68	Eliot.	29·50	70·50	33·62	66·38	†100·00	Storer.
56·60	43·40	49·92	50·05	99·97	Eliot.	do.	do.	23·62	66·38	†100·00	Storer.
54·70	45·30	48·26	51·42	99·68	Storer.	27·50	72·50	33·85	65·81	99·66	Storer.
52·70	47·30	47·47	52·53	†100·00	Cooke.	26·50	73·50	32·08	67·60	99·68	Storer.
. .	. .	. .	. .	. .	. .	26·00	74·00	30·74	69·06	99·80	Cooke.
50·70	49·30	46·89	53·11	†100·00	Cooke.	25·50	74·50	30·43	69·51	99·94	Storer.
do.	do.	46·45	53·55	†100·00	Cooke.	25·00	75·00	29·88	70·20	100·08	Cooke.
48·70	51·30	48·66	51·34	†100·00	Eliot.	24·50	75·50	28·76	71·24	100·00	Cooke.
46·70	53·30	46·77	53·23	†100·00	Eliot.	23·50	76·50	27·93	71·85	99·78	Cooke.
44·80	55·20	44·26	55·73	†100·00	Eliot.	22·50	77·50	26·62	73·27	99·89	Storer.
43·80	56·20	44·04	55·96	†100·00	Cooke.	21·50	78·50	24·83	74·74	99·57	Cooke.
42·80	58·20	43·15	56·93	100·08	Cooke.	20·12	79·88	20·58	79·42	100·00	Cooke.
do.	do.	43·06	56·50	99·56	Cooke.						
do.	do.	42·83	57·24	100·07	Cooke.						

Curve of Variation in Composition.—In order to compare together the composition of the crystals and that of the alloy in which they form, I have resorted to the usual method of Analytical Geometry, and in the plate illustrating this paper, the lower horizontal line is the axis of abcissas, and the vertical line at the extreme left the axis of ordinates. The first has been divided into equal parts, which denote the per cents. of zinc in the crystals and the last into parts of the same size, which stand for the per cents. of zinc in the alloys. The zinc rather than the antimony determinations have been selected for comparison, as being generally more accurate, and as having been all made in exactly the same way. The points determined by analysis are indicated with dots, and the double line drawn through these dots is a curve, which represents the relation of the composition of the crystals to that of the alloy in which they form. In order to make clear the connection between the two, it will be well to discuss this curve, commencing with what may be termed the two centres of crystallization, the alloys of 42·8 and 31·5 per cents. of zinc, and examining the effect produced on the crystals by diminishing or increasing the amount of zinc in the alloy.

It has already been stated that the crystals of $Sb\,Zn_3$ are obtained in their greatest perfection from the alloy of 42·8 p. c. of zinc. They are then comparatively large, generally aggrega-

* In this analysis the antimony only was determined.
† In this analysis the zinc only was determined.

ted, and, as the three analyses cited in the former paper prove, have the same composition as the alloy. On increasing gradually the amount of zinc in the alloy up to 48·7, the crystals continued to have the composition of the alloy, and the only difference, which could be observed in their character, was, that they were smaller and more frequently isolated. Between these limits, the whole mass of the alloy exhibited a strong tendency to crystallize, and, by pouring it, as it cooled, from one vessel to another, it could be crystallized to the last drop. The portion *a*, *b*, of the curve is therefore a straight line equally inclined to the two axes. On increasing the amount of zinc in the alloy to 50·7 p. c., the amount of zinc found in the crystals was only 46·89 p. c., and above this it was uniformly less than it was in the alloy; but no closer relation between the two could be detected, owing undoubtedly to the unavoidable irregularity in the crystallizations of the alloys, which contained more than 50 p. c. of zinc. This arose from a peculiar pasty condition, which the fluid mass assumed, at the point of crystallization, apparently caused by the separation of the excess of zinc. Definite crystals however were obtained even from the alloy of 60 p. c. of zinc, which contained 55 p. c.; above this, the crystals became less and less abundant, and gradually faded out, although the alloy even of 86 p. c. of zinc exhibited a radiated crystalline texture; and a trace of this structure could still be discovered even in the alloy containing only 4 p. c. of antimony. It might be supposed that on returning to the alloy of 42·8 p. c. of zinc, and increasing the amount of antimony we should obtain crystals containing an excess of antimony; but so far is this from being true that the slightest excess of antimony entirely changes the character of the crystallization. On crystallizing an alloy containing 41·8 p. c. of zinc not a trace of any prismatic crystals could be seen, but in their place there was found a confused mass of thin metallic scales, which, as will soon be shown, are imperfect crystals of $Sb\,Zn_2$. Thus it appears that although perfectly formed crystals of $Sb\,Zn_3$ can be obtained containing 55 p. c. of zinc they can not be made to take up the slightest excess of antimony.

In order to obtain crystals having the composition of $Sb\,Zn_2$, that is, containing 33·5 p. c. of zinc, it is necessary to crystallize an alloy at least as low as 31·5 p. c. of zinc. At this point large compound crystals are obtained corresponding to the large crystals of $Sb\,Zn_3$. On increasing the amount of zinc in the alloy up to 33 p. c., the proportion of zinc in the crystals appeared to increase in the same ratio, so that the curve of $Sb\,Zn_2$ is at this part a straight line parallel to the curve of $Sb\,Zn_3$. It should however be noticed that the extent of this line *k i* is so limited that a very small error in the analyses might change very considerably its direction. The crystals of $Sb\,Zn_2$ containing an excess of zinc,

are smaller and more frequently isolated than those containing exactly two equivalents. A similar fact, it will be remembered, is true of the crystals of $Sb\,Zn_3$. At the alloy of 33 p. c. of zinc, the definite crystals of $Sb\,Zn_2$ begin to disappear and are succeeded by thin metallic scales, which, as the two following facts will prove, are imperfect crystals of the same crystalline form. First, the scales from the alloy of 33 p. c. are frequently found having a definite crystal as a nucleus, when it is evident that their surfaces are extensions of the basal plane O of fig. 2 of the former memoir. Secondly, the scales twin together like the large tabular crystals of $Sb\,Zn_2$, forming a cellular structure, and the angle between two scales thus united, measured with an application goniometer approximately 115° 30′, and was therefore equal to the basal angle of the definite crystals. These scales continue up to the alloy of 41·8 p. c. of zinc, becoming however constantly less abundant and less distinct. Several specimens of them were analyzed, but no regularity in their composition could be detected except that they all contained a very much larger amount of zinc than the alloys in which they formed. This irregularity and the imperfection in the crystallization seem to be caused by the interference of $Sb\,Zn_3$, that is, by a tendency to form $Sb\,Zn_3$ which exhibits itself in a proneness of the crystals of $Sb\,Zn_2$ to an excess of zinc. The line *k i* has been continued with dots in order to show that the influence of $Sb\,Zn_2$ extends as far as the alloy of 42·8 p. c. of zinc. On returning to the alloy of 31·5 p. c. of zinc and adding an excess of antimony it was found that the crystals formed continued to have the theoretical composition of $Sb\,Zn_2$ until the amount of zinc in the alloy had fallen to 27 p. c., so that the tendency towards the theoretical composition was so great, that in the alloys between 31·5 and 27 p. c. of zinc, crystals were formed having very nearly this composition. On still further increasing the amount of antimony in the alloy, the composition of the crystals gradually approached that of the alloy, and from the alloy of 20·2 p. c. of zinc, very imperfect crystals were obtained having almost the same composition as the menstruum. At the same time, the crystals became less and less perfect and finally disappeared altogether in the alloys below 20 p. c. of zinc.

The portion of the curve *k m n h*, is the most important result of this investigation and therefore deserves especial notice. It has been shown that crystals of the form of $Sb\,Zn_2$, or at least crystalline scales of the same character, are formed in the alloys between 20 and 43 p. c. of zinc, the first per cent. corresponding to Sb Zn and the second to $Sb\,Zn_3$. Half way between these two points, that is the alloy of 31·5 p. c., is the point where crystals having the calculated composition of $Sb\,Zn_2$ are first obtained. Were the variations in the composition of the crystals of $Sb\,Zn_2$ exactly proportioned to the excess of zinc or of anti-

mony in the alloy, as is the case with $Sb\,Zn_3$, then the curve of variation would be the straight line formed by the continuation of the line *a b*. From this line *b h* the course of the curve is deflected by the force which determines the union of the elements in definite proportions, and which for the want of a special term, I will call the Chemical Force. This is so strong that the curve runs parallel to the axis of ordinates through the distance *k m*. Beyond this point, the influence of the excess of antimony in the alloy becomes stronger than the chemical force, and the curve gradually bends towards the line *h b* which it finally meets at *h*. In the portion *h n* of the curve, the analyses are best represented by the arc of a circle, of which the radius equals *h e* or one-half of *h b*, and to which the line *k m* is tangent. In the portion *n m* the points determined by analysis may also be connected by the arc of a circle of which the radius *o' n* equals the difference between the radius *o n* and twice *g n*, so that the two centres are at the same distance from the line *a h*. The whole curve is evidently the result of two forces; one acting along the chord in the direction *b h*, a force tending to increase the amount of antimony in the crystals proportional to the amount in the alloy, the same force in fact, which acts undisturbed in forming the portion of the curve *b a*; the other the chemical force acting in the direction of the tangent *k m*. It has already been stated that crystals having the calculated composition of $Sb\,Zn_2$ are not first formed in the alloy of the same composition 33·5 p. c. of zinc, but in an alloy containing two per cent. less; so that the line *m k*, instead of extending to *e*, changes from this direction at *k*, and afterwards runs parallel to the line *b h*. Unless this fact can be explained by a tendency in $Sb\,Zn_2$ to an excess of zinc caused by the influence of $Sb\,Zn_3$ as suggested above, the reason of this difference between $Sb\,Zn_2$ and $Sb\,Zn_3$ in this respect is not clear; but as some evidence that it is not accidental it may be stated, that the distance *k c* equals *c i*, the last point being the one, at which the tangent line *m k* extended meets the curve. Another remarkable fact whose bearing cannot be at present seen, but which like the last serves to corroborate the general accuracy of the result was pointed out by my colleague, Prof. Peirce, after the plate had been engraved. The distances of the three most important points of the curve of $Sb\,Zn_2$ from the line *a h*, viz. *k d*, *m f*, and *n g*, are simple multiples of the first; *n g* is twice and *m f* three times *k d*. The curve has been fixed, as will be noticed from the dots, by a large number of points determined throughout the greater part of its length at every per cent., and in the portion *m n* at every half per cent.; they certainly coincide with the curve as closely as could possibly be expected, and the very agreement of so many different determinations by three separate analysts is a strong proof of the general correctness of the work.

By making hypotheses in regard to the nature of the two forces, which have generated the curve just described, it would not be difficult to obtain for it a mathematical expression; but as such hypotheses, in our ignorance of the nature of these forces, would be premature, I must content myself with giving its geometrical construction on a chart ruled like the plate illustrating the memoir. Let the coördinates of any point of the curve be, x = per cent. of zinc in the crystals, and z = per cent. of zinc in the alloy. In order to construct the curve of $Sb\,Zn_3$, find a point (a) of which $x = z = 43$ p. c. (the calculated per cent. of $Sb\,Zn_3$) and draw a straight line $a\,b$ equally inclined to the two axes in the direction from the origin. To construct the curve of $Sb\,Zn_2$, produce the line $a\,b$ in the opposite direction to the point $x = z = 20$, which will be the lowest point of the curve. Find next a point (k) of which $x = 33{\cdot}7$ p. c. (the calculated per cent. of $Sb\,Zn_2$ is $33{\cdot}5$) and $z = 31{\cdot}5$ p. c., which is one-half of $43 + 20$. Through this point draw a line $m\,k$ parallel to the axis of ordinates and intersecting the line $a\,b\,h$ at c. The line $m\,i$ is the tangent, and the line $b\,h$ the chord of the required arc. On the line $m\,i$ take $c\,i = c\,k$, and i is the point at which the arc should touch the tangent. Erect a perpendicular on the tangent at the point i, take $o\,i = \frac{1}{2}\,b\,h$, and from o as a centre, with a radius $= o\,i$, describe the arc $h\,i$. Also from the centre o let fall a perpendicular $o\,g$ on the chord $b\,h$, and produce it to a point o' making $o'\,g = o\,g$. It will intersect the arc at (n). From o' as a centre with a radius $o'\,n$ describe a second arc $n\,m$ intersecting the tangent at m. Finally, draw from k, a straight line $k\,l$, parallel to $b\,h$, then the broken line $l\,k\,m\,n\,h$ will be the required curve.

It will be noticed that the tangent which has been drawn on the plate through the points determined by analysis is two-tenths of a per cent. in advance of the line which would correspond to $Sb\,Zn_2$. This position is essential to the equality of $k\,c$ and $c\,i$, if we retain as the value of the radius of the larger arc $R = \frac{1}{2}\,b\,h$. If the analyses should have given erroneously too much zinc so that the true position of the line should be at $x = 33{\cdot}5$ per cent., then this equality would be destroyed, and the conditions for finding the centre o would be reduced to the coördinates of the point h, the length of the radius and the position of the tangent, from which by a very simple construction the curve might be drawn. It should however be remarked that the position of the tangent in advance of the line $x = 33{\cdot}5$ is in accordance with the fact, already noticed, that the crystals of $Sb\,Zn_2$ have throughout a proneness to an excess of zinc caused apparently by the influence of $Sb\,Zn_3$; but it is also true that the tendency of the error in the zinc determinations is in the same direction.

Before discussing the conclusions to which the facts already stated seem directly to point, it will be well to see how far the variation in composition corresponds to a variation in the properties of the two compounds. Three classes of properties have been examined in this connection, viz., Specific Gravity, Crystalline Form, and Affinity for Oxygen, which will be treated of in order.

Specific Gravity.—The specific gravities of all the crystals analyzed, as well as that of the zinc and antimony used in the investigation, were taken with the greatest care. The determinations were made with a nicely constructed specific gravity bottle, as this method was found susceptible of greater accuracy than any other, when the temperature was observed with precision. In calculating the specific gravity, the weight of the water was corrected for the temperature, so that the unit is in all cases distilled water at 4° C. A similar correction could not be made for the temperature of the substance, as the coefficients of expansion of the crystals are not known. The results of the determination all made by myself are collected in the following table in the column headed "Sp. Gr. by Experiment." In the column

Specific Gravities of Crystals, formed in the Alloys of Zinc and Antimony.

Composition of the Alloys.		Composition of the Crystals		Sp. Gr. of Crystals by Experiment.	Mean Sp. Gr. of Zinc and Antimony.	Expansion in Crystallizing.
Per ct. of Zn.	Per ct. of Sb.	Per ct. of Zn.	Per ct. of Sb.			
100·00				7·153	7·153	0·000
*96·00	4·00			7·069	7·134	0·065
*86·20	13·80			6·898	7·086	0·188
*76·30	23·70			6·769	7·039	0·270
70·40	29·60	64·20	35·80	6·699	6·982	0·283
66·50	33·50	61·00	39·00	6·628	6·967	0·339
64·50	35·50	58·56	41·44	6·596	6·956	0·360
62·50	37·50	55·53	44·47	6·506	6·941	0·435
60·60	39·40	55·00	45·00	6·440	6·939	0·499
58·60	41·40	50·39	49·61	6·396	6·917	0·521
56·60	43·40	49·95	50·05	6·388	6·915	0·527
48·70	51·30	48·66	51·34	6·404	6·909	0·505
46·70	53·30	46·77	53·23	6·376	6·900	0·524
44·80	55·20	44·26	55·74	6·341	6·888	0·547
42·80	57·20	43·09	56·91	6·327	6·882	0·555
*40·00	60·00			6·386	6·867	0·481
*35·00	65·00			6·404	6·844	0·440
33·00	67·00	35·37	64·63	6·401	6·845	0·444
29·50	70·50	33·62	66·38	6·384	6·837	0·453
27·50	72·50	33·85	66·15	6·383	6·838	0·455
26·50	73·50	32·08	67·92	6·400	6·829	0·429
26·00	74·00	31·07	68·93	6·418	6·824	0·406
25·50	74·50	30·43	69·57	6·428	6·822	0·394
24·50	75·50	28·76	71·24	6·449	6·813	0·364
22·50	77·50	26·62	73·38	6·453	6·803	0·350
21·50	78·50	24·83	75·17	6·467	6·795	0·328
*15·00	85·00			6·564	6·748	0·184
*10·00	90·00			6·603	6·725	0·122
*5·00	95·00			6·655	6·701	0·046
	100·00			6·677	6·677	0·000

* Alloys not crystallized.

headed "Mean Sp. Gr. of Zinc and Antimony" are given the calculated specific gravities of the same crystals on the supposition that the two metals had undergone no expansion on uniting. The last column was obtained by subtracting the numbers of the former from those of the latter, and therefore shows the relative amount of expansion. On examining the table, it will be found 1st. That the union of antimony and zinc is accompanied by expansion. 2nd. That the specific gravity of the crystals varies slightly with the composition. 3d. That the two minimum specific gravities correspond precisely to the composition of $Sb\,Zn_3$ and $Sb\,Zn_3$, so that the specific gravity increases and the expansion diminishes as you depart on either side from these two centres. 4th. That the specific gravity of $Sb\,Zn_3$ is smaller than that of $Sb\,Zn_5$. We find then that the specific gravity determinations confirm in general the results of the analysis pointing out the same two centres of crystallization.

Crystalline Form.—It has already been stated that only two crystalline forms can be obtained from the alloys of zinc and antimony, that of $Sb\,Zn_3$ and that of $Sb\,Zn_2$. A large number of crystals of $Sb\,Zn_3$ from different alloys, and therefore containing different proportions of zinc, were carefully measured for the purpose of ascertaining whether the angle was at all affected by the variation of composition. Fortunately four different crystallizations afforded excellent crystals, the angles of which could be measured to a minute. The crystals contained respectively 43·15, 44·14, 46·90 and 55·00 per cents. of zinc, and on all these by repeated measurements the angles were found to be *identical* with those given under figs. 1 and 2. Crystals from many of the other alloys were also measured, but on account of the imperfections of their surfaces the angles could not be determined within five or ten minutes. In all these cases however the values of the angles given above were included within the limits of uncertainty.

The faces of the crystals of $Sb\,Zn_2$ are not generally so perfect as those of $Sb\,Zn_3$, nor is their tabular form so well adapted for measurement; moreover variations in some of the angles have been noticed in crystals from the same crystallization amounting even to ten minutes. The angle 0 on 1 however appeared to be very constant for in all cases where it could be accurately measured the same value was obtained. As none of the crystals of $Sb\,Zn_2$, containing an excess of antimony, could be measured with precision, no constant variation of angle could be detected and on the other hand it could not be proved to be invariable.

Affinity for Oxygen.—The affinity of the crystals of $Sb\,Zn_3$, of different compositions, for oxygen, may be estimated by comparing the amounts of hydrogen gas evolved in a given time on boiling alloys of the same composition with water. The results

of such experiments were given in the former memoir in a table, a mere glance at which will discover the two following facts—

1st, That up to 40 per cent no great increase in the amount of hydrogen evolved is obtained by increasing the amount of zinc in the alloy.

2nd, That at the alloy containing 42 per cent. of zinc there is an immense maximum confined at most between two per cent on either side.

General Conclusions.—Before stating the conclusions to which as I think the facts now established directly point, it will be well to consider the only two admitted principles of chemical science which could possibly be brought forward to explain similar variations. They are, first, that of impurities in crystals; second, that of isomorphous mixtures. It will not be difficult to show that the variations in composition of $SbZn_2$ and $SbZn_3$ cannot be caused by either of these principles.

It is a well known fact that crystals frequently take up impurities which are either dissolved or mechanically suspended in the menstruum in which they form, and it might be supposed at first sight that the excess of zinc or antimony in $SbZn_3$ or $SbZn_2$, bore the same relation to their crystals that the sand does to the rhombohedron of calcite from Fontainebleau, or oxyd of iron and chlorite to crystals of quartz; but, in the first place, in all cases where a considerable amount of impurity is present the crystals are either imperfect or else the angle is considerably changed at times even as much as two or three degrees; and secondly, as such impurities are merely mechanical, the amount in the crystals would in all probability be proportional to the amount present in the menstruum at the time of their formation. Now in the crystals of $SbZn_3$, from the alloy of 60 p. c. of zinc, there is present an excess of zinc amounting to 15 p. c. and nevertheless the crystals are as perfect as, and their angles identical with, those obtained from the alloy of 43 per cent. In the crystals of $SbZn_2$ the excess of zinc is to a certain limit directly proportional to the excess in the alloy, but in those of $SbZn_2$ the excess of antimony is far from obeying this rule; and were the excess in both cases a mechanical mixture the variation in both cases would undoubtedly follow the same law: again, the crystals of $SbZn_3$, take up an excess of zinc but do not take up an excess of antimony, while those of $SbZn_2$ crystallize with an excess of either, —facts which are as inconsistent with the idea of mechanical impurity as the last: finally the form of the curve of $SbZn_2$ of itself alone proves that the excess of antimony in the crystals is not in the condition of mechanical impurity; for in that case the variation of composition would not be influenced, as the curve shows that it is, by the chemical force.

A theory that the variation in composition resulted from the mixture of two or more isomorphous compounds would be even less tenable than the one just discussed. For in the first place it would be necessary to assume the existence of two other compounds of zinc and antimony isomorphous with $SbZn_2$ and of one other, if not more, isomorphous with $SbZn_3$. Not only would such an assumption be contrary to all the analogies of chemistry and therefore require strong evidence to sustain it; but in the second place it can almost be demonstrated that no such compounds exist. The crystals having the calculated composition of either $SbZn_3$ or $SbZn_2$ are marked as has been shown by striking peculiarities, and with one possible exception similar peculiarities were not observed throughout the whole series of crystals which have been examined. The crystals containing 50 per ct. of zinc and of the composition of $SbZn_4$ were found to have a slightly smaller sp. gr., than those just above or just below them, but the difference is so small that it may be accidental, and as the crystals exhibited none of the other peculiarities, which characterize crystals having the calculated composition of $SbZn_3$ or $SbZn_2$, I could not attach sufficient weight to the one circumstance to feel authorized in admitting a third compound of zinc and antimony. Admitting however the existence of $SbZn_4$ yet, as exactly the same angle has been observed in crystals containing 55 per cent. as on those containing 43 per cent of zinc, it would be necessary in order to explain the variation in composition by the principle of isomorphous mixtures, to assume the existence of still a third compound isomorphous with $SbZn_2$, and containing more zinc than $SbZn_4$, which would increase greatly the improbability of the theory in question. Again, the only probable compound of zinc and antimony containing less zinc than $SbZn_2$ would be $SbZn$; and it will be remembered that the crystals of $SbZn_2$ which contained the largest excess of antimony corresponded very nearly to this compound. In like manner the crystals of $SbZn_2$ which contained the largest excess of zinc corresponded very nearly to $SbZn_3$. If then the excess of antimony or zinc in the crystals of $SbZn_2$, arises from a mixture of isomorphous compounds, it must be that $SbZn_3$, $SbZn_2$ and $SbZn$ are isomorphous. That the first two are not isomorphous may be seen by turning back to the description of their crystalline form; and that there is no crystalline compound $SbZn$ is sufficiently proved by the fact that the crystals of $SbZn_2$, which correspond most closely to it, are so very imperfect that they would hardly be recognized as crystals did they not form the lower limit of a series. Several other facts pointing in the same direction might be added, but sufficient it is thought has been said to show that the variations of composition described in this paper can not be explained either by mechanical impurities in the crystals or by the mixture of isomorphous compounds.

In the absence of any known principle of chemical science by which the remarkable variations of composition, that have been demonstrated in this memoir, can be explained, the conclusion is almost forced upon us that zinc and antimony are capable of uniting and producing definite crystalline forms in other proportions than those of their chemical equivalents: in other words, that the law of definite proportions is not so absolute as has been hitherto supposed. The explanation then of the variation of composition which I would offer is: that it is due to an actual perturbation of the law of definite proportions produced by the influence of mass. I suppose for example that in the crystals of $SbZn_3$, containing 55 per cent. of zinc, the zinc and antimony are united in exactly the same way as in those containing 43 per cent., or in other words, just as if the equivalent of zinc were increased to 52·57, that of antimony remaining the same. In support of this position I would offer two considerations. The first is that if the variation is not caused by mechanical impurities or by the mixture of isomorphous compounds, we can conceive of no other explanation for the phenomenon than the one offered. This of course is merely negative evidence; for although science as yet presents us with no principle for explaining variations of composition other than those which have been discussed, and although we can conceive of none others, it does not follow that others may not exist or may not hereafter be discovered; but, nevertheless, this consideration is important inasmuch as it meets an obvious objection, which would be urged against any new doctrine, which conflicts with a generally received canon of chemical philosophy. The second consideration has the character of demonstration. It is that the curve of variation is evidently generated by a second force counteracting directly the chemical force. This second force, as has been shown, is exerted by the excess of one or the other element present in the menstruum, and it may therefore be appropriately termed the force of mass. While the chemical force tends to make the curve a straight line parallel to the axis of ordinates, the force of mass would reduce it to a straight line making an angle of 45° with the axis; under the influence of both these forces it follows the arc of a circle between the two. Now I urge that the character of this curve proves that the chemical force has been directly influenced by what we have called, the force of mass, in the same way that the irregularities of the orbits of the planets prove that the force of gravitation exerted by the sun has been disturbed in its action by the influence of the other members of the system. As the details in the form of the curve have been fully discussed in the previous part of the memoir, it does not seem to be necessary to dwell upon this argument, and I would therefore without further comment offer the curve as it has been laid down on the plate as the proof of the

validity of the explanation of the variation in composition here advanced.

It is worthy of remark that while the curve of variation may be said almost to demonstrate that the law of definite proportions may be disturbed in its action, it also most clearly sustains the integrity of the law itself; for, as may be seen on inspection, the chemical force is sufficiently strong to retain the curve of $Sb\,Zn_2$ parallel to the axis of ordinates through a variation in the menstruum of nearly five per cent., and it is only when the excess of antimony present in the alloy exceeds six per cent. that the force which it exerts becomes strong enough to disturb the action of the law. What the nature of the disturbing force is must be for the present a matter of theory. I am inclined to think that it is a phase of the chemical force itself, in the same way that the perturbations in the motions of the planets are a secondary result of the force of gravitation.

Accepting the view of the subject, which has been offered, it will be obvious that the very large extent of the variation in the compounds of zinc and antimony is due to the very weak affinity between these elements. Were the chemical force stronger in proportion to the disturbing force the variation would be lessened; were it weaker, the variation would be increased. This is illustrated in the difference between the curve of $Sb\,Zn_3$ and that of $Sb\,Zn_2$. It is evident from the action of chemical agents on the two compounds, that one equivalent of antimony and two of zinc are united by a stronger force than one equivalent of antimony and three of zinc, and we find that the crystals of $Sb\,Zn_2$ retain the calculated composition under a considerable variation in the composition of the menstruum, while the composition of those of $Sb\,Zn_3$ varies with the slightest increase of the amount of zinc in the alloy.

To what extent this perturbation of the law of definite proportions prevails among chemical compounds it must remain for future investigation to determine. There are however a number of facts which tend to prove that it is very general whenever chemical affinity is weak. Four of these I will cite as being remarkably analogous to the facts under discussion.

1. Rieffel, to whose investigation of the compounds of tin and copper we have already referred, says, after the paragraph quoted in the introduction to this memoir, "Les aiguilles de $CuSn_{24}$ sont plus grosses que celles de $CuSn_{48}$". "*On croit, sans oser l'affirmer, qu'elles sont, par compensation, en nombre moindre, et que des differences analogues ont lieu dans les autres* $CuSn\varphi$ *à mesure que* φ *augmente jusqu' à* $\varphi=\infty$, *ou jusqu' à l'étain pur.*" It will be noticed that the difference between these needles is precisely the same as the difference between the crystals of $Sb\,Zn_3$ containing a small and a large amount of zinc, and I think

that no one after reading Rieffel's paper can doubt that the compounds of copper and tin vary in composition like those of zinc and antimony.

2. The mineral Discrasite, a compound of silver and antimony, crystallizes in trimetric prisms, of which I on $I = 119° 59'$.* The analyses given below are copied from Dana's System of Mineralogy, changing slightly the order.

$Sb\,Ag_3$ = Antimony 28·5 Silver, 71·5 = 100. $Sb\,Ag_4$ = Antimony 23, Silver 77 = 100.

1. Andreasberg (foliated granular),	Antimony	24·25	Silver	75·25 = 99.5,	*Abich.*
2. Wolfach (coarse granular),	"	24	"	76 = 100,	*Klaproth.*
3. Andreasberg (foliated granular),	"	23	"	77 = 100,	"
4. " " "	"	22	"	78 = 100,	*Vauquelin.*
5. Wolfach (fine granular),	"	16	"	84 = 100,	*Klaproth.*

It needs no comment on these results to show that Discrasite is homœomorphous with $Sb\,Zn_3$, and varies like it in composition.

3. In a paper recently published,† W. Sartorius von Waltershausen gives descriptions and then analyses of a new mineral occurring with Dufrenoysite in the Binnen Valley, Switzerland, in Dolomite. As the analyses do not agree with each other and do not correspond to a simple formula, von Waltershausen regards the compound as consisting of two hypothetical isomorphous compounds $Pb\,S + As\,S_3$ and $2Pb\,S + As\,S_3$ and calculates the proportions in which these compounds are mixed in the specimens analyzed. He infers that they are isomorphous from their analogy in composition to Zinkenite and Heteromorphite, $Pb\,S + Sb\,S_3$ and $2Pb\,S + Sb\,S_3$ which he regards as isomorphous. Prof. J. D. Dana questions the isomorphism of the last and thinks that the hypothesis that the new compounds are isomorphous requires further evidence.‡

4. It is stated by Staedeler§ that crystals of the compound of grape sugar and common salt can be obtained containing for every equivalent of grape sugar one or two equivalents of chlorid of sodium and also of intermediate composition. He states moreover that "Calloud, who first observed that the grape sugar of honey combined with chlorid of sodium, found that the amount of the latter varied between 8·3 and 25 per cent." Staedeler refers the variation in composition to a mixture of the compound of one with the compound of two equivalents of chorid of sodium which he assumes to be isomorphous. He adds that it may be caused by "enclosed crystals of chlorid of sodium although the eye could not distinguish any heterogeneous constituents."

All the above compounds are examples of weak chemical affinity accompanied by large variations in composition without any

* Dana's System of Mineralogy, 4th ed., vol. ii, p. 35.
† Poggendorff's Annalen, vol. xciv, p. 115.
‡ American Journ. of Science, vol. xix, p. 355.
§ Chemical Gazette, vol. xiii, p. 44.

change in the general crystalline form. It is not meant to assert that the variations are identical in character with those of $Sb\,Zn_3$ and $Sb\,Zn_2$, but only that there is a strong probability that this is the case, which in the first two instances amounts almost to a certainty.

If variations in composition of such magnitude are possible when the force of chemical affinity is weak, it is highly probable that some variation may occur when the force is strong, and, whatever view may be taken of the cause of the variation it will now become a matter of importance to ascertain whether many discrepancies in analyses hitherto referred to imperfections in the process, may not be owing to the same cause which influences the composition of the crystals of zinc and antimony. For this purpose, it will be best to make several analyses of the same compound, prepared under circumstances differing as widely as possible, and then to apply to the results "Peirce's Criterion for the rejection of doubtful observations." Such investigations will be greatly simplified by tables prepared by Dr. B. A. Gould* for facilitating the application of this criterion to which I would refer all chemists who are inclined to take up this line of investigation.

I am well aware that in announcing the existence of perturbations of the law of definite proportions I am calling in question one of the most fundamental dogmas of chemical philosophy, and that the new doctrine will have to encounter prejudice on this very ground. This law is so intimately associated in many minds with the atomic theory, that, to such, absolute definiteness seems to be its essential characteristic; nevertheless, I can not but believe that, laying aside the prejudices which the theory begets, it will be seen by all, that the analogies of nature support the doctrine of variation as maintained in this memoir. The phenomena of some of the phenomenal† laws of nature have that definiteness of character which is claimed for those of the chemical law. The planetary orbits are not perfect ellipses. The ratios of the harmony scale are but approximately realized. The arrangement of leaves on the stem is not perfectly regular. Isomorphism is seldom absolute. In all we observe only a tendency towards a maximum effect which is the perfect expression of the law, but which is rarely fully reached. The limits of variation are broader in some instances than in others, but we find no case in which there is absolutely none. This same character which pervades the other phenomenal laws of nature, I claim for

* Astronomical Journal, vol. iv, p. 81.

† I have used the term phenomenal laws to designate a class of laws of nature which are empirical in their character inasmuch as they are obviously not ultimate, although their deviation has not been discovered, but which are more universal than those to which the term empirical is commonly applied.

the great law of chemistry. The definite proportion I regard as a maximum toward which the chemical force strives, a maximum, from which the deviations in most cases are small, although in others it may be very large; and I maintain that this view of the subject, which the memoir has aimed to establish, is supported by the analogies of nature.

When the dynamical law has been discovered, of which the phenomenal law was merely the outward manifestation, as Kepler's laws were merely the phenomena of the law of universal gravitation, the very variations have been seen to be necessary consequences of the law itself, and if even the dynamical law, which governs chemical phenomena, shall be discovered, it is most probable that the variations from the law of definite proportions will become as much a matter of calculation as the perturbations of Astronomy. In both cases the perturbation is apparently due to the influence of an extraneous mass of matter.

The argument from analogy becomes stronger, when we consider the equivalent numbers. I have shown in a former memoir* that these numbers may be connected by a very simple numerical law, but here, as in other cases, we find merely a tendency towards the law, not an absolute agreement with it, the differences between the theoretical and the experimental equivalents being in many cases too great to be covered by errors of observation. The present memoir may throw light upon these discrepancies; for, to say the least, it is possible that the differences may originate in variations of the equivalent itself, and that the theoretical equivalent may be the maximum towards which the chemical force tends. On comparing carefully the different determinations of the chemical equivalents, many facts may be noticed supporting this view; those equivalents for example, which coincide with or very nearly approach whole numbers such as those of oxygen, carbon and sulphur, will be found as a general rule to have been determined by the analysis or synthesis of compounds whose elements are united by a strong force; also when the equivalents have been determined by essentially different processes it will be noticed that they seldom perfectly agree; so that whatever view may be taken of the subject it will now become a matter of the highest importance to ascertain how far, if at all, the determinations of the chemical equivalents have been influenced by similar causes to those which have produced the variations described in this memoir. This influence can only be detected by multiplying the determinations, by as many different processes as possible, and submitting the results to a rigorous mathematical scrutiny.

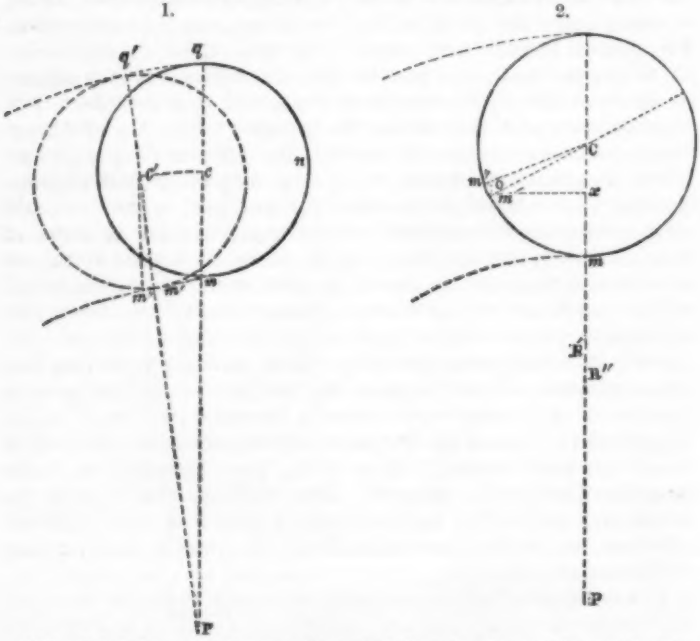
If the doctrine of this memoir is correct and the chemical equivalents are really liable to variation it will have an important

* This Journal, vol. xviii, p. 229,

influence on chemical philosophy. The atomic theory as at present interpreted by chemists is irreconcilable with it, and our present ideas in regard to isomorphism must be materially changed. But it must be remembered that the conclusions of the memoir are drawn from the examination of only two compounds, and therefore that it would be premature to dwell on these obvious consequences of the principle until it has been substantiated by further investigations. In conclusion, I would express my obligation to the gentlemen who have assisted me in the labor of the investigation which on account of the large number of analyses has been very great and could not have been concluded so soon had it not been for their great industry and zeal.

ART. XXIII.—*Demonstration of the Apparent Motion of the plane of Oscillation of the Pendulum, due to the Earth's Rotation;* by J. G. BARNARD, A.M., Brevet Maj. Engineers U.S.A.

LET P be the pole of the earth, and C be the central point of a dial represented by the circle *mnq** over which the pendulum swings; the whole projected upon the plane of the equator.



* The dial circle would of course, be projected, on the plane of the equator in an ellipse; but for convenience is represented as a circle.

In the reasoning which follows the radius Cm representing the semi-oscillation of the pendulum is supposed, as indeed it always is, exceedingly minute compared with the earth's radius; it is also very minute compared with CC′ which measures the rotary movement of C during a semi-oscillation.

C being the centre of motion, the bisecting point of each arc of oscillation, its *rotary* velocity about the earth's axis will evidently be that of the pendulum itself.

Even if we suppose the pendulum as commencing its series of oscillations at either of the points q or m and thence having *their* rotary velocities, the very first vibration will check or accelerate it to that of C.

While the pendulum is moving from, C to m, suppose the centre of motion C to move to C′ by the earth's rotation; the point m of the dial; will only have the velocity due to the radius of the earth's small circle Pm. Its motion will be mm' while that of C is CC′ due to the radius PC.

But the pendulum having the rotary velocity of the point C will advance, in rotation a distance, from its original plane mq, equal to CC′. Instead therefore of striking the dial circle at m' it will strike it in advance of it a distance $m'm''$ equal to $CC'-mm'$.

That is to say, *the distance the pendulum advances each vibration is equal to the difference of the arcs of the circle described about the earth's axis by the points* C *and* m, *during the vibration.*

The foregoing proposition has been derived from the consideration of the pendulum vibrating in the plane of the meridian.

But it can be established in a more general way by considering a semi-vibration in any other plane Cm'. (Fig 2.)

In this case the pendulum will gain in the *direction of rotation* upon the point m' (where it would strike the dial circle, if the earth was motionless) a distance om'' in the *direction of rotation* due to the difference of rotary velocities of the points C and m' or x. Such an increment in the ordinate from x will cause an increment mm' of arc the same as just found for the vibration in the plane of the meridian.

For, call V the rotary velocity of C, the time of a semi-oscillation, t: the radius PC$=$R′ and that P$m$$=$R″. (Fig. 1.)

The rotary velocity of the point m will be $\frac{R''}{R'}V$, and the *difference of velocities* of C and m, $V\left(\frac{R'-R''}{R'}\right)$. The distance $m'm''$ gained by the pendulum will therefore be (in case of vibration in the plane of the meridian) $=Vt\left(\frac{R'-R''}{R'}\right)$.

For the case of oblique vibration (Fig. 2), call $mx = x$ (x being an abscissa of the dial circle), and the ordinate $xm' = y$.

The point of the dial m' will have a velocity $= \frac{R'' + x \sin \Phi}{R'} V$ (Φ being the latitude) and the difference of rotary velocities between it and C will be $V\left(1 - \frac{R'' + x \sin \Phi}{R'}\right)$ and the distance om'' gained, in the direction of rotation, by the pendulum, will be, $Vt\left(1 - \frac{R'' + x \sin \Phi}{R'}\right)$.

But the increment of abscissa om' corresponding to the increment of ordinate om'' will be determined by the equation of the circle, these increments (being very small) being as the differentials of y and x.

Call $r\left(= \frac{R' - R''}{\sin \Phi}\right)$ the radius of the dial circle, then

$om' : om'' :: dx : dy :: \sqrt{2rx - x^2} : r - x$; hence $om' = om'' \frac{\sqrt{2rx - x^2}}{r - x}$

$= Vt\left(1 - \frac{R'' + x \sin \Phi}{R'}\right) \frac{\sqrt{2rx - x^2}}{r - x} = \left(\text{since } r = \frac{R' - R''}{\sin \Phi} \text{ and hence } 1 - \frac{R'' + x \sin \Phi}{R'} = \frac{r - x}{R'} \sin \Phi\right) Vt \frac{\sqrt{2rx - x^2}}{R'} \sin \Phi.$

Hence

$$\overline{m'm''}^2 = \overline{om''}^2 + \overline{om'}^2 = V^2 t^2 \left[\frac{(R' - R'' - x \sin \Phi)^2}{R'^2} + \frac{2\left(\frac{R' - R''}{\sin \Phi}\right) x - x^2}{R'^2} \sin^2 \Phi\right]$$

which, being developed, reduces to

$$V^2 t^2 \frac{(R' - R'')^2}{R'^2}, \text{ hence } \overline{m'm''} = Vt \frac{R' - R''}{R'},$$

an expression the same as obtained for the case of vibration in the plane of the meridian, and constant for all positions of the plane of vibration.

It is then proved that, at each vibration, the plane of vibration will shift on the dial through an angle whose arc, on the dial circumference, will be equal to the difference between the arcs of rotation described during the same time by the centre and extremity of the meridional diameter of the dial.

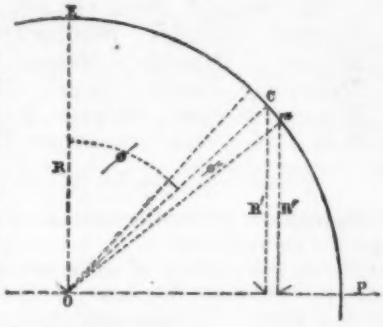
After a complete revolution of the earth, the length of the arc of the dial passed over, or which measures the angular change of plane of vibration will be, evidently, equal to the difference be-

tween the total circumferences of the two small earth's circles, just mentioned.

3.

Let P*mc* be a meridional section, EO the equator, Φ latitude of C, and Φ' half the angle subtended by the chord of vibration C*m*, and R the earth's radius.

R′ and R″ are the radii of the circles of rotation of the points C and *m;* then $R' = R\cos\Phi, R'' = R\cos(\Phi+\Phi')$ and



$$\text{circumference } R' = 2\pi R\cos\Phi$$
$$\text{“ } R'' = 2\pi R\cos(\Phi+\Phi').$$

We have proved that the length of the arc of the dial moved over by the pendulum in 24 hours is equal to the difference between these circumferences

$$\text{circ } R' - \text{circ } R'' = 2\pi R\,(\cos\Phi - \cos(\Phi+\Phi')) =$$
$$2\pi R\,(\cos\Phi - \cos\Phi\cos\Phi' + \sin\Phi\sin\Phi')$$

where Φ' (as is actually the case) is extremely minute, $\cos'\Phi$ is sensibly $=1$ and the above expression becomes

$$\text{circ } R' - \text{circ } R'' = 2\pi R\sin\Phi\sin\Phi'.$$

But $R\sin\Phi' = Cm$ and $2\pi R\sin\Phi'$ is therefore equal to the circumference of the dial circle.

$2\pi R\sin\Phi\sin\Phi'$ is therefore equal to the dial circumference, or 360° multiplied by the sine of the latitude.

In other words the plane of oscillation will move in 24 hours through an angle equal to 360° × sine of the latitude:— a result arrived at by other methods and proved by observation.

The foregoing demonstration is rigid; it is based upon the simple fact that the pendulum has (with its point and axis of suspension) a rotary motion of its own, around the axis of the earth; and that while this rotary movement is preserved unchanged, the oscillation of the pendulum is governed by the same laws in reference to its *axis of suspension* as if both were motionless in space; a supposition on which all the investigations of the phenomena of gravitation, as applied to the earth and heavenly bodies, are based.

It *assumes nothing* unless it be, that the mere *angular motion* which the direction of the axis of suspension and of gravity together undergo, will not permanently alter the direction of the chord of the arc of oscillation.*

* This assumption is capable of proof but it is not worth while to complicate the subject by introducing it here.

ART. XXIV.—*Reëxamination of American Minerals:* PART V. —*The Minerals of the Wheatley Mine in Pennsylvania.—Anglesite; Cerusite; Wulfenite; Vanadate of Lead; Pyromorphite; Mimetene; Galena; Copper; Copper Pyrites; Malachite; Azurite; Blende; Calamine; Hematite; Fluor Spar; Calc Spar; Sulphur*, &c.; by J. LAWRENCE SMITH, M.D., Prof. Chem. Med. Depart. University of Louisville.*

(Communicated to the Am. Scientific Association, August, 1855.)

BEFORE describing the minerals of this mine, it is well to say a word with reference to its location, and also to quote some remarks on the geology of the surrounding country by Prof. H. D. Rogers. Although this is departing from the plan usually adopted in this series of papers, still the occurrence of all the minerals, here described, at one locality, cannot but render the geology of the place interesting to mineralogists.

This mine is situated in Chester Co., near Phœnixville, Pennsylvania, and is one of several interesting developments of a thorough and very able exploration of this region by Mr. Charles M. Wheatley. At the request of Mr. Wheatley, Prof. Rogers made a geological examination of the metalliferous veins of this district, and the following remarks are taken from his report.

"These veins belong to a group of lead and copper-bearing lodes of a very interesting character, which form a metalliferous zone, that ranges in a general east and west direction across the Schuylkill River, near the lower stretches of the Perkiomen and Pickering Creeks in Montgomery and Chester Counties, and bids fair to constitute at no distant day a quite productive mineral region.

"The individual veins of this rather numerous group, are remarkable for their general mutual parallelism, their average course being about N. 31°—35° E. by compass, and not at all coincident with that of the belt of country which embraces them. They are true lodes or mineral injections, filling so many dislocations or fissures, transverse to the general direction of the strata which they intersect. The metalliferous belt ranges not far from the boundary which divides the gneissic or metamorphic rocks of Chester County from the middle secondary red shale and sandstone strata."

"This vein varies in thickness from a few inches to about two and a half feet, nnd we may state its average width at not less than eighteen inches. It is bounded by regular and well-defined, nearly parallel walls, the prevailing material of which is a coarse, soft granite, composed chiefly of white feldspar and quartz.

"It would seem to be a pretty general fact that such of these veins as are confined entirely or chiefly to the gneiss, bear *lead* as their principal metal; whereas, those which are included solely within the

* I am indebted to Prof. J. D. Dana for the figures and mathematical descriptions of the crystals given beyond.—J. L. S.

red shale are characterised by containing the ores of copper. But the zinc ores, viz., zinc blende and calamine, prevail in greater or less proportions in both sets of veins, existing, perhaps, in a rather larger relative amount in the copper-bearing lodes of the red shale."

"The *gneissic strata* of the tract embracing this group of lead-bearing veins, seem to differ in no essential features from the rest of the formation ranging eastward and westward through this belt of country. Here, as elsewhere, they consist chiefly of soft thinly bedded micaceous gneiss, a more dense and ferruginous hornblendic gneiss, and thirdly a thicker bedded granitic gneiss, composed not unfrequently of little else than the two minerals, quartz and feldspar.

Penetrating this quite diversified formation are innumerable injections of various kinds of granite, greenstone trap, and other genuine igneous rocks. The granites, as throughout this region generally, consist for the most part, of a coarse binary mixture of quartz and opaque white feldspar, tending easily to decomposition. This rock abounds in the form of dykes and veins, sometimes cutting the strata of gneiss nearly vertically, but often partially conforming with its planes of bedding for a limited space, and then branching through, or expiring in it in transverse or tortuous branches. A not uncommon variety of granitic dyke is a simple syenite composed of quartz, greenish semi-translucent feldspar, and a smaller proportion of dark green hornblende. A soft, white, and partially decomposed granite is a very frequent associate of the stronger lead-bearing veins, particularly in their more productive portions; but this material belongs, in all probability, not to the ancient granitic injections of the gneiss, but to those much later metalliferons intrusions which filled long parallel rents in that formation with the lead ores and their associated minerals."

"The gneissic strata and their granitic injections, throughout this district display a softened, partially decomposed condition, extending in many places to a depth of twenty fathoms."

"Of the dozen or more lead and copper lodes of greater or less size brought to light in this quite limited region of five or six miles length and two or three miles breadth, the greater number are remarkably similar in their course, ranging N. 32°—35° E., and S. 32°—35° W.; and what is equally worthy of note, they dip, with scarcely an exception, towards the same quarter, or south-eastwardly, though in some instances so steeply as to approach the perpendicular."

"There is no marked difference in the general character of the veinstones of the several mineral lodes, nor any features to distinguish as a class those of the red shale from those of the gneiss."

The minerals found in these veins are quite numerous, and among them, there are specimens of species hardly equalled by those coming from any other locality. Prof. Silliman, in his report on the minerals of this mine exhibited at the Crystal Palace, says, that the specimens of sulphate and molybdate of lead are the most magnificent metallic salts ever obtained in lead mining, and unequalled by any thing to be seen in the cabinets of Europe.

48. *Anglesite.*

This mineral is found abundantly and in beautiful crystals at this locality. The magnificence of many of the specimens can only be realized by seeing those in Mr. Wheatley's cabinet. The crystals are remarkable for their size and transparency;—in some instances, they weigh nearly half a pound being as transparent as rock crystal in nearly every part. Crystals with terminations at both ends have been obtained five and a half inches in length by one and a half in thickness; perfectly limped crystals an inch in length are quite common.

The following are some of the forms:

1.—0, ∞, $1\text{-}\breve{\infty}$.

2.—0, $\frac{1}{2}\text{-}\bar{\infty}$, $\infty\text{-}\bar{\infty}$, 1, α, $1\text{-}\breve{2}$, $1\text{-}\breve{\infty}$, $\infty\text{-}\breve{\infty}$.

3.—0, $\frac{1}{4}\text{-}\bar{\infty}$, $\frac{1}{2}\text{-}\bar{\infty}$, ∞, $1\text{-}\breve{2}$, $2\text{-}\breve{4}$

4.—0, $\frac{1}{2}\text{-}\bar{\infty}$, $\infty\text{-}\bar{\infty}$, $\frac{3}{4}\text{-}\frac{3}{2}$, 1, ∞, $1\text{-}\breve{2}$, $2\text{-}\breve{4}$, $1\text{-}\breve{\infty}$.

Sometimes the crystals of this mineral are full of cavities, and of a milk-white color; but these do not differ in composition from the colorless and transparent forms. It also occurs in circular crystals.

It is sometimes colored. There is a black variety produced by the more or less perfect admixture of the sulphurets of lead and copper (containing traces of silver) in the mass of the crystals, whose form is not altered. There are crystals of a delicate green color arising from carbonate of copper, and others of a yellow color due to oxyd of iron.

The transparent and colorless variety is remarkably pure. Its sp. grav. is 6·35. On analysis it afforded,

	1.	2.
Sulphuric acid,	26·78	26·61
Oxyd of lead,	73·31	73·22
Silica,	·20	
	100·29	99·83

according very precisely with the formula $\dot{P}b\bar{S}$.

I would call attention to the method of analyzing this sulphate, as described in another paper, for it was analyzed in the moist way by dissolving it first in citrate of ammonia.

The anglesite of this mine is found variously associated. It is common to find it in geodic cavities in galena, the cavities being lined with hematite varying in thickness from $\frac{1}{16}$ to $\frac{1}{2}$ an inch or more, and often this hematite contains anglesite intimately mixed in the mass. It may occur in crystals occupying a portion of the geode, or it may fill its entire capacity, assuming the form of the cavity. It is also found compacted in the galena without the appearance of any cavity or the presence of any other mineral; acicular crystals occur diffused through the galena. Observed also on copper pyrites, with a thin layer of hematite inter-

vening between the crystal and the pyrites—on crystals of zinc-blende in quartz—on quartz associated with pyromorphite—on galena with crystals of sulphur—on calc spar without any associate. One very interesting specimen consists of a flattened crystal an inch square, having a delicate crystal of calc spar over an inch and a half in length perforating the centre and around which the sulphate appears to have formed. It is also found on fluor spar without associate.

Some of the most beautiful specimens are where large crystals of anglesite are covered with crystals of carbonate of lead, these latter frequently penetrating the anglesite.

49. *Cerusite.*

The crystals of this mineral, though not as large as those of anglesite, are yet exceedingly beautiful, both in size as well as transparency; the twin crystals are often two inches broad, transparent and presenting the appearance of the spread wing of a butterfly, some of the single crystals are an inch in length and half an inch thick.

A transparent crystal weighing five grammes, gave a sp. grav. of 6·60 and on analysis furnished

Carbonic acid,	16·38	$\}$ = $\dot{P}b\ddot{C}$
Oxyd of lead,	83·76	$\}$
	100·14	

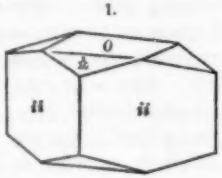
It occurs in hematite coating galena, in a manner similar to the anglesite, and associated with it: also in connection with pyromorphite, which often colors the entire body of the crystals of cerusite. It is found on galena without the association of any other mineral—on green and blue carbonate of copper—on pyromorphite which often covers the entire surface of the cerusite crystals, imparting to them an opaque yellowish green color—on oxyd of maganese in snow-white crystals, without any other associate—on hematite in a similar manner; mamillary masses of the hematite sometimes pass through the crystals Some few specimens have been found consisting of crystals of galena, with a number of very fine hemitrope crystals of cerusite on the surface. The cerusite is occasionally covered with an exceedingly thin coat of oxyd of iron giving the crystals a dark red appearance, and some of them again with a very thin layer of pyromorphite, as delicate as if it had been put on with a brush.

The cerusite is sometimes colored, black, green and yellow, in a manner similar to that mentioned under anglesite.

50. *Wulfenite.*

This mineral is found in small crystals of every shade of color from a light yellow to a bright red; it has been found in some

abundance, forming, from the manner of its occurrence, very beautiful specimens. The crystals present a variety of modified forms, tabular and octahedral, one of which is here figured.



Other forms are 0, 1.
0, $\frac{1}{2}$, 1.
0, $\frac{1}{16}$, ∞-∞. (Fig. 1.)

Specific gravity of a dark yellow variety, 6·95.

The composition of both the yellow and red varieties was examined; the difference of color is due to the presence of *vanadic acid* in the red varieties, and the intensity of color is proportional to the amount of vanadic acid, which in no instance is much more than one per cent.

The analyses afforded

	Yellow variety.	Red variety.
Molybdic acid,	38·68	37·47
Vanadic acid,	——	1·28
Oxyd of lead,	60·48	60·30
	99·16	99·05

The second corresponds very nearly to 97 p. ct. of molybdate and 3 p. ct. of vanadate of lead. As the last substance varies in quantity, it cannot be regarded as giving a distinct specific character to the mineral. This mineral has been described as a chromo-molybdate of lead, but by the most careful examination only a trace of chromium can be detected; in fact, the quantity is so minute, as to require further examination in larger quantities to place the matter beyond a doubt.

Wulfenite occurs alone on crystallized and cellular quartz, or associated with pyromorphite, whose beautiful green color is often very much enhanced by the contrast of the yellow and red crystals on its surface.

Sometimes the wulfenite forms the mass, and crystals of pyromorphite are sparsely disseminated over the surface. It is also found in decomposed granite—on carbonate of lead and oxyd of manganese—also associated with vanadate of lead.

51. *Vanadate of Lead* (*Descloizite?*)

This species has never before been remarked among American minerals, although the chloro-vanadate (vanadinite) was first discovered in Mexico. This adds another to the list of curious minerals from the Wheatley mine. It was noticed about a year ago in the form of a dark colored crystalline crust, covering the surface of some specimens of quartz and ferruginous clay associated with other minerals. Observed with a magnifying glass, it is seen to consist principally of minute lenticular crystals, grouped together in small botryoidal masses; the crystalline structure is perfect. Thus seen, the color of the mass is of a dark purple,

almost black. When seen by transmitted light, the color is dark hyacinth-red and translucent. The streak is dark yellow. From the difficulty of obtaining any quantity of sufficient purity, nothing accurate can be stated with reference to its specific gravity and hardness; and for the purpose of analysis, I was obliged to use material, which although containing pure crystals of the vanadate, was yet mixed with crystals of molybdate of lead and other impurities.

The chemical analysis is an imperfect one, yet the best that can be made from the mineral as it has been found. It is as follows:

Vanadic acid,	11·70
Molybdic acid,	20·14
Oxyd of lead,	55·01
Oxyds of iron and manganese, Alumina,	5·90
Oxyd of copper,	1·13
Sand,	2·21
Water,	2·94
	99·03

If we subtract the amount of oxyd of lead requisite to form Wulfenite with the molybdic acid present, we have left 22·82 per cent. which is combined with 11·7 of vanadic acid, making a compound corresponding to, Vanadic acid 66·1, oxyd of lead 33·9=100.

This result is not considered precise; it corresponds however, more nearly with the composition of Descloizite as given by Damour ($\dot{P}b^3\ \ddot{V}=\ddot{V}$ 29·3, $\dot{P}b$...70·7), than with Dechenite by Bergmann ($\dot{P}b\ \ddot{V}=\ddot{V}$ 45·34 $\dot{P}b$ 54·66).

The composition of Descloizite cannot be considered as having been fairly made out, for Damour's results are deduced, as mine have been, from a very impure material, and may on future examination prove to be $\dot{P}b^3\ \dot{V}^2$; corresponding in composition to the chromate of lead called Melanochroite. This mineral has as yet been found only in small quantity at this mine, associated with oxyd of manganese and wulfenite, the crystals of this latter substance being more or less covered with minute crystals of the vanadate.

52. *Pyromorphite.*

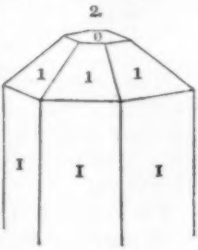
There are several shades of color belonging to this mineral, a green so dark as to be almost black, olive-green, pea-green, leek-green, greenish yellow and all intermediate shades. It is a very abundant ore at the Wheatley Mine, and large quantities of it are smelted. Specimens of great beauty are found occurring in botryoidal masses with columnar structure, in perfect hexagonal prisms with the summits more or less modified. Crystals are found $\frac{1}{2}$ inch in diameter. Some of the crystals are hollow with only an hexagonal shell; sometimes the crystals are agglomerated in a plumose form.

A dark green variety gave a sp. grav. of 6·94. No analysis was made of this mineral, as it will be embraced in an examination of the American pyromorphites to be published at some future time.

It is found in decomposed granite, on quartz crystals, occasionally covering their entire surface; in cellular quartz with molybdate of lead; in large masses of grouped crystals with small crystals of yellow and red molybdate inserted on crystals of sulphate and carbonate of lead, and forming a coating to large surfaces of galena.

53. *Mimetene.*

The specimens of this mineral that have been found, although few in number, are remarkable for their beauty of crystallization. Some of the crystals are nearly colorless and perfectly transparent, others of a lemon-yellow, either pure or tinged with green. The form is that of a perfect hexagonal prism, the edges of the summit most commonly truncated, often to such an extent as to terminate the crystal with a hexagonal pyramid, (fig. 2). The crystals are sometimes as small as a hair, and a quarter of an inch or more in length, and again they are so broad and short as to form hexagonal plates half an inch across.



A specimen of the lemon-yellow variety was examined; it gave a sp. grav. of 7·32, and was found to contain,

Arsenic acid,	23·17
Chlorine,	2·39
Oxyd of lead,	67·05
Lead,	6·99
Phosphoric acid,	·14
	99·74

corresponding to, Arsenate of lead 80·21, chlorid of lead 9·38 = $Pb^3 \dot{A}s + \frac{1}{4} Pb\,Cl$

This specimen of mimetene is seen to be almost free from phosphoric acid, containing only about $\frac{1}{1\,6}$ of a per cent., in this respect resembling that from Zacatecas as analyzed by Bergmann.

This mineral is found in granite or quartz. It is also associated with pyromorphite and sometimes the two run together, so as to present no distinct line of demarcation between them; some of the specimens consist of the two minerals, the pyromorphite forming one entire surface, and mimetene the opposite surface, and between, various shades of the mixture. It has been found with galena and carbonate of lead.

54. *Galena.*

The compact, fibrous and crystallized varieties of galena occur at this mine. Fine crystals are found, either a perfect cube, cube

with modified edges and angles, octahedron and rhombic dodecahedron often very much flattened out and occasionally rounded to an almost globular form; these rounded crystals are usually covered with pyromorphite. The galena is sometimes cellular, arising from partial decomposition, the exterior portion presenting a black drusy appearance, the interior of a bright steel color; this variety is particularly rich in silver and also contains crystals of sulphur.

The galena is argentiferous, giving an average yield of thirty ounces to the ton. It is found associated with quartz, calcite and fluor spar, frequently inserted in the crystals of these substances; it is also a common associate of all the minerals of this locality. Some of the cubical crystals have their surfaces partly decomposed and covered with a layer of crystals of carbonate. Specimens are found of very large cubical and octahedral crystals forming slabs several square feet in surface completely covered with a layer of leek-green phosphate. The cavities of the galena frequently contain sulphur.

55. *Copper.*

Native copper is found only in delicate films on hematite, or quartz crystal, and forms an interposing layer between the hematite and copper pyrites.

56. *Copper Pyrites.*

Copper pyrites is found in some cases in sufficient quantity to be worked as an ore; some of the masses are of considerable size weighing three or four hundred pounds. Fine crystals are obtained, both tetrahedral and octahedral. It affords on analysis

Sulphur,	36·10
Copper,	32·85
Iron,	29·93
Lead,	·35
	99·23

It occurs alone and associated with the other sulphurets. It is found in various parts of the vein, there being no special point of deposit.

57. *Malachite.*

Malachite occurs in small reniform masses, consisting of fibrous crystals, and of a bright green color; also in silky tufts of a very light green color, which are associated with azurite and carbonate of lead. Its sp. grav. is 4·06. An analysis gave:

Carbonic acid,	19·09
Oxyd of copper,	71·46
Water,	9·02
Oxyd of iron,	·12
	99·69

affording the formula $\dot{C}u\,\ddot{C}+\dot{C}u\,\ddot{H}$

It is associated with the various ores of copper and lead of the Wheatley mine, and sometimes so thoroughly diffused through the sulphate and carbonate of lead as to give them a uniform green tint. It is not found in any quantity.

58. *Azurite.*

This mineral, although rare, is found in beautiful crystals some measuring from $\frac{1}{4}$ to $\frac{1}{2}$ inch across, of a deep blue color, and highly polished faces. Its sp. grav. is 3·88. An analysis gave,

Carbonic acid,	24·98
Oxyd of copper,	69·41
Water,	5·84
	100·23

giving the formula $2\dot{C}u\,\ddot{C}+\dot{C}u\,\ddot{H}$.

This species occurs in similar associations with the malachite. It is however rarer.

59. *Zinc Blende.*

Blende is found in considerable quantity both massive and crystallized. Some of the crystals are exceedingly beautiful, and of large size, being three or four inches in diameter and with very brilliant surfaces. The colors are dark hair-brown and black, the brown being transparent. The specimens from this locality are hardly surpassed by those from any other mine. A specimen that was analyzed gave the following results:

Sulphur,	33·82
Zinc,	64·39
Cadmium,	·98
Copper,	·32
Lead,	·78
	100·29

It is proposed to examine yet other specimens, to see if there may not be larger amounts of cadmium contained in some of them.

This mineral occurs in fluor spar, calc spar and quartz, more or less mixed with the other sulphurets. In some instances it is very peculiarly interlaced in the rocks; thus we have specimens consisting as it were of four layers, namely, granite, then compact crystallized quartz $\frac{3}{4}$ths of an inch thick, then the blende an inch thick, on that a layer of crystals of calc spar, and on this last fluor spar.

60. *Calamine.*

Calamine is found in delicate crystals of a silky lustre, forming in some instances snow-white tufts on fluor spar, blende and carbonate of lime. It is also found on cellular quartz. Some of the specimens are quite handsome, having a blue and yellow color from the presence of carbonate of copper and oxyd of iron. No analysis was made of any of the specimens.

61. *Brown Hematite.*

This ore occurs in concretionary masses of a dark liver color, and compact structure, associated with nearly all the minerals of this mine—it very commonly forms a lining to cavities in galena, in which are found crystals of anglesite and cerusite; sometimes it lines cavities in the rock that are completely filled with cubical galena. Acicular concretions of the hematite are found traversing crystals of anglesite and cerusite. A specimen of the purest hematite gave for its composition

Peroxyd of iron,	80·32
Oxyd of copper,	·94
Oxyd of lead,	1·51
Water,	14·02
Silica,	3·42
	100·21

62. *Fluor Spar.*

The remarkable feature of the fluor spar of this mine is the absence of color; all the specimens yet found being colorless and transparent. The crystals are very perfect and beautiful, yet small; it is sometimes in globular concretions, of crystalline structure radiating from the centre. The cube, which is the more common crystalline form, is sometimes very much modified by the truncation of the edges and angles. A specimen that was examined gave a sp. grav. of 3·15, and the following composition:

Fluorine,	48·29
Calcium,	50·81
Phosphate of lime,	*a trace*
	99·10

It is associated with calc spar, and in some instances in a remarkable manner, mentioned under the head of calc spar. Galena and blende are interspersed through it. Its occurrence in the mine was first noticed at the depth of three hundred feet, and since then it has been found abundantly.

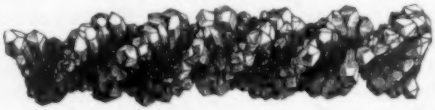
63. *Calc Spar.*

There are a variety of interesting forms and associations of this mineral. The two most common are the dog-tooth spar and the hexagonal prism with a three-sided summit, and occasionally the hexagonal prism with flattened summits like arragonite. Sometimes slabs of this mineral are found, with a surface of eight or ten square feet completely covered with prismatic crystals an inch or two in length, and from ½ an inch to an inch in thickness; they are mostly vertical, but occasionally horizontal with double terminations. These crystals are sometimes of a remarkable character, being eight or ten inches in length and only a quarter of an inch in diameter, preserving a tolerably perfect hexagonal shape throughout the entire length; again, these slender forms are built up of small hexagonal prisms, their faces projecting

from the side. It sometimes happens that these slender crystals are crossed by one of the same diameter, and less length, firmly attached in the manner of a cross.

But of all remarkable crystallizations is one, where the small prisms are so arranged as to form a perfect double spiral arranged around an axis, (fig. 3); the specimen is three inches in length

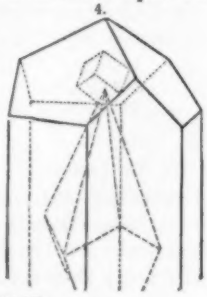
2.



and $\frac{3}{8}$ths of an inch in diameter, with the space of a $\frac{1}{4}$th of an inch between each turn of the spiral. The spiral arises from one small prism crossing another at middle at a small angle of divergence (40°–50°), and so on in succession. These slender crystals are sometimes curved in a very remarkable manner.

Another thing to be remarked in connection with the calcite of this mine, is its singular associations; thus, we find groups of hexagonal prisms where a small cubical crystal of fluor, about the $\frac{1}{20}$th of an inch, is inserted in a small pit in the summit of almost every crystal (fig. 4) without the occurrence of fluor spar on any other parts of the crystal. These crystals appear to have been formed by successive crystallizations. Dog-tooth spar seems to have been first formed with these small crystals of fluor spar on their extremities, and then by a subsequent process, the calcite has closed around the dog-tooth spar in the form of a hexagonal prism with a three-sided summit. The summit never closes entirely at the centre, the fluor spar remaining visible on one side, and where there is no crystal of fluor spar the extremity of the dog-tooth spar is frequently seen.

4.



Other groups of calcite crystals, have minute crystals of iron pyrites in the three faces of the summit, arranged near and per-

5.

6.

fectly parallel to the alternate edges as seen in figure 5. Every crystal in the group is thus furnished with a set of crystals of pyrites.

In another group of crystals the pyrites in equally small crystals is found in three lines on the summit of every crystal running from the apex towards the edges, exactly bisecting each face as seen in figure 6.

In this instance, as well as in the former, the pyrites is inserted entirely beneath the surface of the crystal, which is perfectly smooth.

The calcite is found in large crystals in dolomite, and is associated with most of the ores of the mine. It sometimes gives rise to pseudomorphs of molybdate of lead and carbonate of lead; these pseudomorphs are mere shells however, retaining the form of the calcite.

64. *Sulphur.*

Sulphur occurs in the form of small pale greenish yellow crystals; they are transparent and disseminated through cellular galena which appears to have undergone partial decomposition; the galena in which it occurs is frequently associated with copper and iron pyrites and in some rare instances with carbonate and phosphate of lead.

The other minerals occurring in the Wheatley mine are finely crystallized *quartz*, *oxyd of manganese*, *iron pyrites*, *sulphate of baryta*, *indigo copper*, *black oxyd of copper*, and *dolomite*.

Of the other mineral veins in this region, none have yielded the beautiful mineral species furnished by the Wheatley vein. The Perkiomen vein, five miles from the Wheatley vein, has furnished fine *capillary copper*, *indigo copper*, fine acicular crystals of *sulphate of baryta*, *crystallized copper*, and some crystals of *sulphate*, *carbonate* and yellow *molybdate of lead*, but these last were small and bear no comparison to those described.

It was hoped that something might be learned concerning the formation of the minerals of this vein, but the difficulties and uncertainty attendant upon the study of questions of this kind make it prudent to postpone any views that might be suggested. It may, however, be well to remark that in opening the vein and descending from the surface for the first thirty feet, the phosphate of lead was very abundant with some galena and carbonate; a little lower down the phosphate was less, and the carbonate more abundant. Wulfenite and anglesite began to appear at 120 feet, the phosphate and carbonate still continued with the galena, with fine large crystals of anglesite and considerable wulfenite; at 180 feet, phosphate very much diminished, carbonate and sulphate in fine crystals; arsenate was found here; at 240 feet, blende, calamine and fluor spar appear with considerable dolomite and but little phosphate of lead, galena forming almost the whole lead ore, anglesite is found, but in smaller crystals. These observations may hereafter lead to some conclusions as to the manner of the formation of these minerals, but at present I prefer dismissing the subject without further remarks.

ART. XXV.—*On the Meteorology of Oroomiah;* by Rev. D. T. STODDARD.*

THE village of Seir, where we reside, is in the province of Oroomiah, in Northern Persia, in latitude 37° 28′ 18″ north, and in approximate longitude 45° east from Greenwich. We are about 40 miles from the boundary of Turkey and 150 from that of Russia. The village is on the grassy slope of a mountain, which rises 2834 feet above the neighboring city of Oroomiah and 7334 above the ocean. The side of the mountain on which we live faces the northeast, and is consequently somewhat bleak in winter. The snow also lies upon it in the spring long after it has disappeared from the southwestern side.

From the village of Seir we look down on the very beautiful and extensive plain of Oroomiah, forty miles in length and from twelve to twenty miles in breadth, which possesses a deep alluvial soil and bears on its fertile bosom several hundred villages. The city of Oroomiah, the ancient Thebarma, situated near the centre of the plain, as well as many of the villages, is surrounded by innumerable gardens and orchards, and rows of poplars, willows and sycamores, which make large portions of the plain resemble a continued forest. The mountains of Koordistan encircle the plain on three sides, while to the east lies the lake of Oroomiah, studded with islands and reflecting the pure azure of an Italian sky.

This plain is watered by three rivers of moderate size, which come down from the Koordish mountains, and are distributed by a network of small canals and water courses over its whole surface. Without artificial irrigation but few crops can be brought to maturity, although here and there wheat fields are cultivated on the slopes of the neighboring mountains, which are wholly dependent on the rains of the spring and early summer, and sometimes yield a tolerable harvest.

The principal productions of the plain of Oroomiah, the annual mean temperature of which is of course considerably above that of Seir, are wheat, barley, corn, millet, flax, tobacco, rice, cotton, castor oil, apples, pears, plums, grapes, (which are cultivated in immense vineyards) cherries, apricots, nectarines, peaches, melons, pomegranates, almonds and the jujube. The fig, with care, may also be cultivated, but is often destroyed by the cold of winter.

The lake of Oroomiah, the ancient Spautes, is about ninety miles long by thirty broad†. Its water has been thus analyzed by President Hitchcock:

* From a letter to Professor D. Olmsted, dated Seir, Oroomiah, January, 8, 1855.
† Its elevation above the ocean is 4100 feet.

In five hundred grains.	Grains.
Chlorid of calcium,	0·74
Chlorid of manganese,	5·76
Chlorid of sodium,	90·58
Sulphate of soda,	5·67
	102·75*

In the water of this lake it is impossible for a man to sink, the specific gravity being 1·155, and those who bathe in it come out encrusted with salt. In the summer, its shores are also fringed with a broad, white margin of salt, produced by evaporation. The lake exerts of course a marked influence on the climate of this region, and, as will be seen from the tables, produces a regular land and sea breeze in the summer months. During the day a light wind blows from the lake, aad during the night a fresher wind from the lofty mountains of Koordistan, which rise some forty miles west of the lake, to the height of 10 or 12 or perhaps 13 thousand feet above the ocean, and generally retain on their summits, even in summer, deep masses of snow. The amount of watery vapor is thus probably much greater in Oroomiah than in many parts of Persia, which present almost the barrenness of the Arabian deserts.

It should be mentioned in this connection that all the mountains in Northern Persia are destitute of trees, and many of them rise to a great height in naked rocky summits. Indeed, in the valleys and on the plains, it is rare to find any trees, except those planted by the hand of man, and a stranger, as he looks down on the luxuriant plain of Oroomiah, can hardly be made to believe that the millions of trees before him are entirely an artificial growth.

I regret that it has not been convenient for me to take *hourly* observations on the temperature, at least so far as to fix the proper times of observation for this region. Hourly observations, which have been made in countries remote from Persia and in climates entirely different from this, on the basis of which the tables of Kaemtz and others are founded, I have supposed would avail little for my purpose. The hours selected were those which suited best my convenience. I also desired to procure the extremes of temperature, which are here almost uniformly just before sunrise and at two or three in the afternoon. Of course, the average of the tables is below the actual mean temperature, though I am unable to say how much. It may however be interesting to mention, that a very large spring, just above our house on the mountain side, maintains throughout the year the temperature of 53° Fahrenheit. I have never found, summer or winter, a variation of more than half a degree.

* See an article in the Transactions of the Association of American Geologists and Naturalists.

1. *Thermometer and Wet Bulb Hygrometer.*

1852.	Monthly means of Thermometer.				Monthly means of Hygrometer.				Diff. between Therm. & Hygr.				Therm. highest	Date.	Therm. lowest.	Date.	Diff.	Greatest change in twenty-four hours.
	Sunrise	2 P. M.	10 P. M.	Mean.	unrise	2 P. M.	10 P. M.	Mean.	Sunrise	2 P. M.	10 P. M.	Mean.						
April,	40°·8	54°·4	44°·50	46° 56	38°·9	46°·6	40°·	41°8	1°·9	7°·8	4°·5·	4°·76	65°	22d & 24th	30°	15th	35°	20°, 2d.
May,	52°·45	65°·5	56°·90	58° 28	45°·8	54° 07	47°·13	49°	6°·65	11°·43	9°·77	9° 28	77°	12th	41°·5	4th	35°·5	19°, 8th.
June,	57°·1	72°·6	62°·70	64°·13	49°·9	58°·6	52°·7	53°·7	7°·2	14°	10°	10° 43	78°	16th	52°	5th	26°	23°, 5th,
July,	65°·5	78°·8	70°·14	71°·48	54°·9	61°·45	56°·3	57° 5	10°·6	17°·35	13°·84	13° 98	86°·5	25th	59°	10th	27°·5	20°, 8th & 9th.
August,	67°·4	79°·4	71°·37	72°·72	54°·8	60°·4	55°·4	56°·9	12°·6	19°·00	15°·97	15° 82	89°	2d	58°	31st	31°	18°, 4th & 5th.
September	58°·3	70°·9	63°·17	64°·12	50° 68	57°·05	52°·2	53°·31	7°·62	13°·85	10°·97	10°·81	76°	2d	52°	30th	24°	17.° 2d.
October,	48°·7	61°·3	53°	54°·33	43°·6	50°·4	45°·5	46°·5	5°·1	10°·9	7°·5	7°·83	65°·5	6th	44°	26th	21°·5	18°, 16th & 17th.
November.	38°·1	47°·7	40°·80	42°·2	37°	42°	37°·7	38°·9	1°·1	5°·7	3°·1	3°·3	59°	2d	29°	20th	30°	15°·5, 9th & 10th.
December,	30°·7	38°	32°	33° 56	.....	36°·6	.....	.....	.....	1°·4	.....	....	43°·5	4th	21°	30th	22°·5	15°, 26th & 27th.
Jan. 1853,	24°	33°·3	26°·20	27°·82	.....	.....	.....	.....	.....	.....	.....	.....	41°	24th	17°·5	28th	23°·5	18°, 25th & 26th.
February,	28°·8	39°	30°	32° 60	.....	.....	.....	.....	.....	.....	.....	.....	58°	26th	12°	10th	46°	14°·5, 15th & 16th.
March,	35°·9	48°·1	39°·10	41°·03	.....	42°·6	.....	.....	.....	5°·5	.....	.....	57°·5	22d	23°	15th	34°·5	25°, 27th & 28th.
Annual mean,	45°·64	57°·42	49°·15	50°·73														
April,	42°·3	55°	45°·8	47°·7	39°·1	48°·2	42°·5	43°·3	3°·2	6°·8	3°·5	4°·4	64°	26th	32°	1st	32°	19°·5, 27th & 28th.
May,	48°	60°·6	52°·1	53°·5	45°·2	53°·1	48°·2	48°·8	2°·8	7°·5	3°·9	4°·7	70°	24th	42°	3d	28°	21°, 23d.
June,	57°·2	72°·2	62°·3	63°·9	51°·2	59°·5	54°·3	55°	6°·	12°·7	8°	8°·9	80°	27th	49°	1st	31°	21°, 27th & 28th.
July,	63°·4	75°·6	68° 2	69°·1	56°·2	61°·7	57°·8	58°·5	7°·2	13°·9	10°·4	10°·6	81°	24th	56°	10th	28°	15°·5. 8th & 9th.
August,	67°·6	79°·1	71° 6	72°·7	57°·9	63°·8	59°·1	60°·3	9°·7	15°·3	12°·5	12°·4	83°	16th, 20th	62°	4th	21°	15°, 10th.
September	60°·9	69°·4	63°·9	64°·7	54°·6	59°·7	56°·4	56°·9	6°·3	9°·7	7°·5	7° 8	79°	1st	56°	17th	23°	16°, 11th & 12th.
October,	50°·4	58°·8	53°	54°·1	47°·2	52°·5	48°·9	49°·5	3°·2	6°·3	4°·1	4°·6	67°·5	4th	33°	29th	34°·5	14°, 9th.
November.	37°·1	46°·4	39°·1	40°·8	36°·5	43°·2	37°·5	39°·1	0°·6	3°·2	1°·6	1°·7	54°	22d	30°·5	6th	24°·5	14°, 13th, 14th, 15th.
December,	33°·1	39°·6	34°·9	35°·8	.....	37° 6	.....	.....	.....	2°	.....	.....	48°	29th	27°	9th	21°	10°, repeatedly.
Jan. 1854,	24°·7	30°·7	26°·1	27°·2	.....	.....	.....	.....	.....	.....	.....	.....	43°	1st	10°	30th	33°	13°, 17th & 18th.
February,	29°	37°·7	31°·1	32°·6	....	.....	.....	.....	.....	.....	.....	.....	45°	20th, 22d	11°·5	7th	33°·5	17°, 14th & 15th.
March,	29°·3	39°·3	31°·5	33° 3	.....	.....	.....	. ...	.....	.....	.....	.....	49°	24th, 25th	9°·75	9th	39°·25	19° 5, 8th & 9th.
Annual mean,	45°·25	55°·36	48°·3	49°·61														
Mean for 2 years,	45°·44	56°·39	48°·72	50°·17														

N. B. The wet bulb was so often frozen during the winter months that the observations were irregular.

2. *Barometer, Clouds and Rain.*

1852.	Monthly means of Barometer.				Barom. highest	Date.	Barom. lowest	Date.	Diff	Clouds, 0–10.				Cloud's days.	Rain and melt'd snow
	Sunrise	2 P. M.	10 P. M.	Mean.						Sunrise	2 P. M.	10 P. M.	Mean.		
April,	24·177	24·168	24·187	24·177	24·305	20th & 21st,	23·897	27th & 28th,	·488	5·1	6·5	4·2	5·3	0	
May,	24 283	24·301	24·304	24·296	24·421	13th,	24·085	2d.	·336	3·1	4·3	2·	3·1	3	
June,	24·225	24 211	24·211	24·216	24·341	2d,	24·094	19th,	·247	Observations imperfect.					
July,	24·193	24·193	24·189	24·192	24·303	1st,	24·049	8th,	·254	·04	·03	·01	·03	26	
August,	24·246	24·247	24·235	24·242	24·417	26th,	24 097	4th,	·320	,20	·20	·30	·23	20	
September,	24 330	24·325	24·322	24·325	24·45	30th,	24·18	19th,	·270	1·0	1·4	1·8	1·4	12	
October,	24·444	24·433	24·442	24 439	24·53	7th,	24·30	17th,	·230	1·4	2 9	1 0	1·7	6	
November,	24·336	24·333	24·334	24 334	24·47	25th,	24·21	7th,	·260	3·2	5·1	4·8	4 3	3	
December,	24·350	24·361	24·350	24·353	24·59	13th,	24·22	11th,	·370	3·9	5·1	3·8	4·3	2	
January, 1853,	24·330	24·325	24·329	24·328	24·47	19th & 20th,	24·18	23d,	·290	3·8	3 8	3·8	3·8	2	
February,	24 290	24·300	24 313	24·301	24·60	20th,	23·97	6th,	·630	4·7	3·8	4·6	4·4	1	1·42
March,	24·240	24·217	24 324	24·230	24 51	3d,	23·91	14th,	·600	3 6	5·7	3·4	4·2	0	1·41
Annual mean,	24·287	24·284	24·287	24·286						No. of cloudless days, -				75	
April,	24·230	24·242	24·245	24·239	24·40	30th,	24·05	8th,	·35	3·1	5·2	3·	3·8	0	5·22
May,	24·299	24·292	24·297	24·295	24·47	12th,	24·15	4th, 5th & 20th,	·32	2·9	5 3	4·1	4·1	1	2·43
June,	24·219	24 207	24 214	24·213	24·36	1st & 15th,	24·05	29th,	·31	0·9	1·8	2·2	1·6	8	·43
July,	24·219	24·205	24·203	24 209	24·37	18th,	24·12	24th,	·25	1·0	1·2	0·6	0·9	12	·00
August,	24·290	24·285	24·278	24·284	24·38	22d,	24 14	8th,	·24	1·5	1·8	1·1	1·5	6	·48
September,	24·292	24·279	24·277	24·283	24·37	5th, 6th, &c.,	24·05	11th,	·32	1 3	2·3	1·6	1·7	4	·65
October,	24·417	24·411	24·415	24·414	24·53	28th,	24·19	27th,	·34	2·5	4·5	3·2	3·4	1	1·48
November,	24·335	24·328	24·335	24·333	24·49	16th,	24·17	21st,	·32	4·4	5·9	4·	4 7	2	·95
December,	24·305	24·294	24·297	24·298	24·42	23d & 24th,	24·08	6th,	·34	5.	6·2	5·1	5·4	1	1·29
January. 1854,	24·280	24·264	24·270	24·271	24·49	10th & 11th,	24·02	31st,	·47	5.2	4·3	3·2	4·2	4	1·69
February,	24·074	24·078	24·089	24·080	24·41	21st,	23·79	17th,	·62	4·5	6·1	4·7	5·1	1	4·25
March,	24·133	24 134	24·146	24·137	24·44	3d,	23·88	1st,	·56	3·4	6·4	2·9	4·2	0	6·71
Annual mean,	24·258	24·251	24·255	24·255						Am't of rain during the year, - - -					25·58 in.
Mean for two years,	24·272	24·267	24·271	24·271						No. of cloudless days, - -				40	

Barometer highest during the two years, 24·60, February 20th, 1853.
" lowest " " " 23·79, February 17th, 1854.
Extreme range, - - - - - - ·81.

Amount of rain and melted snow for the year ending December 31st, 1855, was 21·62 inches.

As a general rule I have been very systematic and regular in taking the observations and have neglected to record but few each month, excepting those on the winds. I think therefore, if the results are erroneous, it is rather owing to a defect of the instruments than to a want of faithfulness in using them. In regard to the barometer, I have sometimes suspected it was injured in the transportation from America, but my doubts were in a measure removed by finding that it agreed with the Aneroid Barometer of Chevalier Khanikoff and that the measurements of the height of Oroomiah above the ocean are nearly like those of previous observers. The barometrical records are carefully corrected for temperature being reduced to the foregoing point; but, as I did not know the bore of the tube, I could not make the correction for capillarity. The diameter of the bore must however vary from $\frac{1}{6}$th to $\frac{1}{7}$th of an inch. All the instruments have been in a favorable position and about ten feet from the ground.

In one respect, at least, my labor is quite incomplete. As the tables now stand, some *general* notion may of course be formed of the tension of vapor, by noting the difference of the thermometer and hygrometer. But, as the barometrical pressure is always to be taken into account, and the pressure at this altitude above the ocean is much less than in the United States, a general inspection of the tables might lead the reader to very erroneous conclusions as to the dryness of this climate. I should have reduced these observations, if I had had the means of doing so conveniently. I leave this for those who may be interested in the results.

ART. XXVI.—*Correspondence of M. Jerome Nicklès, dated Paris, June* 29, 1855.

Aluminium and Sodium.—Aluminium has already been introduced into the industrial arts. In the session before the last of the Academy of Sciences, M. Dumas exhibited in behalf of M. Deville, large masses of the chlorid of aluminium, and of the metals sodium and aluminium, obtained at the chemical works of Javel. Dumas observed that two to three hundred kilogrammes of chlorid of aluminium had been already made, showing that it may become a material of manufacture on the large scale.

It has been proved that sodium, while superior in energy to potassium, may be prepared by Deville's process, with no difficulties not incidental to the manufacture of the latter metal. Numerous trials have also shown that it may be kept in fusion in contact with the air without inflaming, and that it may be run out of the apparatus which furnishes it. A metal like sodium, brought within the reach of science and the arts, must soon come into extensive use.

M. Dumas also remarked on the fact that the study of aluminium had introduced a new process into the arts for the reduction of ores—that from the chlorid of the metal; and that this method might be important for other metals not yet brought into use. He also mentions the sonorousness of aluminium, a quality in which it compares with the best bronze, having a quality of tone not hitherto observed in any metal in the pure state, which is another peculiarity of this curious metal.

He stated, in reply to inquiries, that the materials employed in making 1 kil. of aluminium—viz., the ammoniacal alum, the alumina which is derived from it, chlorine, carbon, carbonate of soda, chalk, are all of low price. The whole cost is reduced to 32 francs, which is very small, when we consider that the expense of sodium, when the experiments in aluminium were begun, was 1000 francs per kilogram, which alone would make the price of aluminium 3000 francs. M. Balard, who is familiar with industrial applications, stated that he had gone through with the steps of the process at Javel, and was satisfied that the cost of the sodium could be still further reduced when prepared on a large scale.

The chlorid of aluminium is prepared at the Javel works by the reaction of chlorine on a mixture of alumina and coal tar previously calcined—which is easily effected in a gas retort. The condensation of the chlorid is produced in a chamber of masonry, lined with earthen ware. The chlorid contains a little iron, which is removed entirely in treating it for aluminium, by making its vapor to pass over points of iron heated to 400° C. The sesquichlorid of iron, $Fe^2 Cl^3$, as volatile as the chlorid of aluminium, is changed, through contact with iron, into the protochlorid, Fe Cl,—which is relatively very fixed. The vapor of the chlorid of aluminium, on leaving the apparatus, affords colorless transparent crystals.

In preparing the sodium, there are used—

Dry carbonate of soda,	1000 parts.
Chalk,	150 "
Dry coal of Charleroy,	450 "

which are pulverised, mixed with care, and calcined to a red heat in a pot.

Wheatstone long since showed that aluminium was as strongly negative as platinum. M. Hulot, director of the galvanizing works and coinage of Paris, has tried the use of the impure aluminium in a galvanoplastic battery. He has found that a couple of aluminium and zinc, the latter amalgamated some considerable time previously, when charged with water acidulated with a twentieth of sulphuric acid at 66° C., has afforded during the first hours a current at least equal to that from a couple of platinum and zinc, excited to the same degree. After six hours, the current had lost a fifth of its original force. The battery was not completely polarised at the end of 24 hours, and the current still preserved a quarter of its first force. To restore its electro-negative character to the aluminium, it was necessary only to immerse it an instant in nitric acid and then wash it.

According to the Messieurs Tissiers, pure aluminium is easily distinguished from the impure, by its greater whiteness, its indistinct traces of crystallization, and rarely one or two well defined hexagons on the

surface of the ingots, while the impure has a bluish tint like zinc, and if the whole is not crystalline the upper surface is much more so than in pure aluminium, and the form is also quite different. According to one of the most extensive galvanising establishments of Paris, the metal works as well as silver.

It may be whitened easily by dipping the piece in a concentrated solution of soda or potash, and passing it then into nitric acid. This acid acts differently according as it is itself pure or mixed with chlorhydric acid, and according as the aluminium is pure or not.

Aluminium is most easily soldered when alloys are used containing aluminium. The alloys most convenient are those with silver, zinc or tin; the point of fusion being below that of aluminium, the soldering may be done by means of a simple spirit lamp, and without any previous cleaning.

Fulminating power of Silver in the state of Sponge.—Correction.—The sponge of silver and not of silicium possesses the property of fulminating under a heavy pressure suddenly applied—a property on which a remark was made in the last number in connection with the observations of M. Chenot.

Physiological and Therapeutic effects of Carbonic Acid.—Some weeks since M. Herpin, of Metz, stated the following facts to the Academy. Dr. Struve took the Marienbad waters for a painful affection of the leg. He had been unable for several weeks to walk without a crutch. Dr. Struve had the notion one day of exposing his leg to the action of the carbonic acid which escapes freely from the spring at Marienbad, and forms a bed several decimeters deep over its surface. After exposure for a while it produced a pricking sensation and warmth, which went on increasing till it occasioned a profuse perspiration of the diseased limb. On withdrawing then his leg, he was surprised to feel no pain, and to find that he was able to walk without his crutch. He continued this treatment for some time, and has since experienced no return of his complaint.

There are now in Germany special establishments for baths, douches, and the inhalation of carbonic acid. According to M. Herpin, the first effect of exposure to the gas is a sensation of pleasant heat, like that from a garment of fine wool—then a pricking, and afterwards a burning which has been compared to that from mustard.

On the occasion of this communication, M. Boussingault related how he happened in 1826 to witness some of the effects mentioned by M. Herpin. He was visiting in the Quindiu, New Grenada, a part of the Cordillera, some *solfataras*, where numerous workmen were occupied melting and purifying sulphur. He encountered a crevice whence issued abundantly a gas of the odor of sulphuretted hydrogen. He attempted to descend in it in order to ascertain the temperature; but he had hardly entered the crevice when he felt a suffocating heat, which he estimated to be at 40° C., and a pricking in the eyes; respiration being difficult, he ascended quickly; his face was red and his perspiration abundant. After a while he descended again with his thermometer, and was surprised to find a temperature of only 19½° C. The extreme temperature was 22° C. The gas was composed of 95 per cent. of carbonic acid and 5 p. c. of atmospheric air and sulphuretted hydro-

gen. It was hence the carbonic acid which caused the sensation of heat and the irritation of the eyes. At two other times, in 1827 and 1830, M. Boussingault experienced again the same sensations. He observed that the workmen who work long in the solfataras of the Cordillera, in contact with the carbonic acid, experience an enfeebling of the sight, and some of them become blind.

Dr. Herpin confirmed the fact with regard to the action on the eyes of the baths of gaseous carbonic acid. He observed that the douches of carbonic acid had been used against "*amblyopie*" or enfeebling of vision, and different precautions were used to moderate the effects of the gas or diminishing the force of the jet, or its distance; or its direct action by interposing muslin. When the eyes have an inflammatory tendency, it irritates the organ and even the neighboring parts; the heat sometimes produces dangerous congestion.

Thermogenic Apparatus.—For some time past there has been a machine at work on the Quai Valony, at Paris, which furnishes a considerable quantity of steam without any other source than that of friction. The machine consists of a cylindrical heater two meters long, 50 centimeters in diameter, having through all its length, within at centre, a conical tube. The water which is reduced to vapor fills the void space between the inner walls of the heater and the outer of the conical tube. Into the conical tube is passed a cone of wood, covered throughout with a braid of hemp rolled spirally. The cone of wood is traversed by an iron axis, and fills exactly the exterior capacity of the tube, so as to rub constantly against its walls. It is put in motion by a fall of water from the Canal St. Martin, so as to make about 400 turns per minute. The heat from the friction is sufficient to turn to steam the water of the boiler; a thermometer placed within the boiler indicates at the end of a certain time a temperature of 130° C. The boiler is strengthened in the ordinary way, with safety stop-cocks, a float, manometer, &c. The vapor reaches hardly a pressure of $2\frac{1}{2}$ atmospheres. A greasing apparatus conveys constantly to the envelop of the cone the oil required to sustain the motion.

This machine holds 400 litres of water. To be set in action it requires the power of two horses, and then produces steam enough to do the work of one horse. The authors, MM. Beaumont and Major, hope thus to utilize the force of falling water and convert it into heat. This machine is at work at the Crystal Palace of Paris.

Gas from Peat.—There is much discussion in connection with the renewal of the engagements of the city of Paris with the gas companies. Attention has thus been called to the gas from peat, which for some time has been manufactured at Paris. M. Leon Foucault has been charged with measuring the comparative illuminating powers of coal and peat gas; and the result is in favor of that from peat, its power being 342, while that of coal gas is 100.

The manufacture of peat gas is more simple than that of coal. The peat, if put into an iron retort, heated to a low red heat, affords immediately a mixture of permanent gases, and vapors which condense into an oleaginous liquid, which two products separate on cooling. The oil is collected in a special vessel, and the gas passes into a gasometer. This carburetted hydrogen is wholly unfit for illumination, it

giving a very small flame, nearly like that from brandy. The oil from the peat is a viscous blackish liquid, of strong odor; it is subjected to a new distillation, and resolved wholly into a permanent gas and hydrogen very richly carburetted. This mixture is strongly illuminating, giving a flame six or eight times brighter than the first and of more lively brilliancy. The two are mixed, and a gas of intermediate character obtained, which is delivered over for consumption.

M. Foucault has made his trials with a photometric method which will soon be made known. Its unit was not a single wax-candle, but a collection of seven candles, arranged in a hexagonal manner with spaces of one centimeter. A single candle is liable to too much variation, a compensation for which is secured when a number is employed.

By this method, a mean of five determinations gave for a burner of peat gas a light equivalent to $23\frac{1}{4}$ candles; and the same burner with coal gas $6\frac{3}{10}$ candles.

The illuminating power of the pure oil from peat—the illuminating material "par excellence"—has been found, at equal pressures, 705, the intensity for coal gas being 100; and with equal volumes their numbers are as 756 : 100.

Practical Acoustics; Progressive elevation of the diapason of Orchestras.—At the commencement of the 18th century, during the later years of the reign of Louis XIV, the *la* adopted in the orchestra corresponded, according to Sauveur, to 810 vibrations per second; the number now for the *la* of the opera is 898. There has hence been, from 1715 to 1855, a rise of nearly a tone in the diapason of the orchestra. This rise has taken place mainly in the present century, and most rapidly in the last 25 years. The following facts will give some idea of the change.

(1) The *la* of the Royal Chapel under Louis XVI. corresponded to 818 vibrations; (2) in 1808, the *la* of a flute of Holzappel, as estimated by Delezenne, was 853; other diapasons of the same epoch give 857 or 860 vibrations; (3) in 1823, at the Italian Theatre, it was 848, 855 at the Feydeau theatre, 863 at the Opera, 872 at the Conservatoire; (4) in 1834 the *la* at the Opera corresponded to $867\frac{1}{2}$ vibrations, at the Conservatoire 870; (5) in 1855, finally, the *la* of the operas is 898 vibrations.

Thus since 1823 the rise has been nearly a semitone; and it is therefore not astonishing that tenor voices should be so rare.

This rise in the diapason has not reached its limit. In fact, since wind instruments have had great importance in the orchestra, they have necessarily, in consequence of their sonorousness, imposed their tone on stringed instruments. But the diapason of these instruments tends always to rise. This takes place principally through military music, for there the rise of tone has some advantages, it increasing its sonorousness, its acuteness of tone, and therefore its piercing character, and on the other hand diminishing the weight of the instrument. The makers of instruments incline rather to diminish the size, and thereby to raise instead of depressing the diapason.

The manufacturers of pianos have the same tendencies. To obtain the fullest sonorousness, it is necessary to give the strings a tension very near that which is necessary to break them; and consequently, as the

cords are improved in quality, they tend more and more to raise the tone, especially as the instrument admits of this increase of tension without changing its model.

There is also a permanent cause for the rise of the diapason in the method used for tuning. In fact, it is done by the file; and filing a diapason heats it: at the moment it is in tune with the standard, it is thus heated; and when it cools afterwards the tone will rise. When this second diapason is used for tuning, there is another similar rise, and so it continues.

These considerations have led M. Lissajous, Professor of Physics at the College of St. Louis, at Paris, to propose the adoption of a uniform diapason, and means for preserving it. He desires that the question should be settled by an international congress. Without wishing in advance to fix the number to be employed for the normal diapason, he suggests that 1000 vibrations should be taken for the *si* natural of the mean scale of the piano; the *la* corresponding, will then, in the system of equal temperament, correspond to 890 vibrations, which is very near the actual *la* of the Conservatoire, or the mean *la* adopted by the manufacturer. This method will have the advantage of connecting indirectly the scale of sound with the decimal system.

Zincography.—An engraver at Paris, M. Dumont, has just communicated to the Société d'Encouragement a process for electric engraving, which promises much. On a thick plate of zinc, grained with a mallet of steel and fine sand, he designs some subject with a kind of lithographic crayon, and on this he spreads a fine powder made of a mixture of resin, Burgundy pitch and asphaltum: on heating the zinc plate, the powder melts and forms a varnish which spreads over the parts of the surface which have been covered with the lithographic crayon, that is, over the whole design. To obtain the design in relief, he then plunges the plate into a bath of sulphate of zinc in communication with the positive pole of a battery in front of another plate connected with the negative pole. The current passes and corrodes part of the zinc not covered with ink, and the picture comes out in relief. From the plate thus engraved in relief a cast is taken in gutta percha, in which copper is deposited in order to obtain the engraved plate, from which impressions may be had by means of the ordinary typographic press.

On Horseflesh for food.—M. I. Geoffroy St. Hilaire, the President of the Zoological Society for Acclimation and Professor at the Mus. d'Hist. Naturelle, &c., in a course of lectures on animals useful to man, has just devoted two lectures demonstrating the advantages of horseflesh for food. After speaking of the predilection of the ancient Germans for horseflesh, he has inquired into the aversion now so general. Both the Scandinavians and Germans, kept in a sacred pasture a race of white horses for sacrifices to Odin, and after the sacrifice they boiled them for a feast. This is no doubt the origin of the hippophagy which continued among these people until driven out as a part of paganism by the spread of Christianity. Yet in spite of the efforts of Pope Gregory III. and his successors, the use of horseflesh continued for a long time in Scandinavia. The race of white horses is still found pure in the stables of Fredericksberg belonging to the King of Denmark.

The nomadic tribes of Asia retain still their relish for horseflesh although they have an abundance of cattle and sheep.

Among the people of Europe, who have anew taken up the use of horseflesh, the Danes were the first. During the siege at Copenhagen in 1807, it was authorized by the government, and since then it has continued to be eaten. In the Capital of Denmark, there is a butcher's stall for selling horseflesh alone, licensed by the government.

At times it has been introduced into Paris. During the scarcity at the time of the revolution, the greater part of the meat eaten for six months was from slaughtered horses, and no inconvenience resulted from it. Along the Rhine, in Catalonia, and in the maritime Alps, the celebrated Larrey many times had recourse to this article of food for his wounded soldiers. He depended on it mainly at the siege of Alexandria, and owed to it, in a great degree, the cure of the sick.

From these facts and multitude of others he enumerates, M. I. Geoffroy St. Hilaire concludes that horses may be used as wholesome, economical and nutritious food.

Bibliography—Traité Elémentaire de Physique par PÉCLET, Prof. à l'Ecole Céntrale des Arts et Manufactures, 4th edit., 2 vols., 8vo, Paris, Chez Hachette & C^ie^.—M. Péclet, is the author of the celebrated Treatise on heat, and better than almost any one knows to the bottom whatever concerns the imponderable fluids. The questions of practical physics are treated with the hand of a master, as well as theoretical questions. M. Péclet is the first French author who has done justice to M. Ohm in giving to him the priority in the discovery of the law of currents—a discovery which M. Pouillet had succeeded for some years in taking to himself.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the formation of alcohol from olefiant gas.*—BERTHELOT has succeeded in preparing alcohol by causing olefiant gas to unite indirectly with two equivalents of water. The discovery is particularly interesting because hitherto the alcohols have been formed exclusively by fermentation. Pure and previously boiled sulphuric acid by long agitation with olefiant gas slowly absorbed it. The acid on dilution with water and distillation then yielded alcohol. About 32 litres of olefiant gas and 900 gr. of sulphuric acid yielded in this way 52 gr. of alcohol, corresponding to 45 gr. of absolute alcohol. The process appears to depend on the formation of sulphovinic acid and its subsequent decomposition by heat, though the author thinks he has observed differences between the salts of the acid obtained in this way and those of the ordinary acid. Propylene C_6H_6 was found to be absorbed by sulphuric acid as readily as carbonic acid by potash. The liquid diluted with water and distilled, gave a mixture of water and propionic alcohol. Marked differences were observed between the characters of the salts of the acid having the constitution C_6H_7O, HO, $2SO_3$ ac-

cording to the circumstances and modes of preparation. In conclusion, the author states that when propylene gas is exposed to fuming muriatic acid it is slowly absorbed. The action takes place more readily at a higher temperature. The product is a neutral liquid insoluble in water and identical with the chlorid of propyl C_6H_7Cl.—*Ann. de Chimie et de Physique*, xliii, 385, *April*, 1855.

2. *On the theory of the Compounds of Glycerine*—The Lipyl theory of Berzelius has long since ceased to afford a satisfactory explanation of the chemical relations of glycerine, and the discoveries of Berthelot in particular, have rendered a new theory indispensible. Wurtz proposes to consider glycerine as a tribasic alcohol, that is, as containing 3 eqs. of hydrogen replaceable by 3 groups. Glycerine may be reduced to the type of $3(H_2O_2)$ if we suppose C_6H_5 capable of replacing 3 eqs. of hydrogen, then we shall have

$$\left.\begin{matrix}H\\H\\H\end{matrix}\right\}C_6H_5\left\}\begin{matrix}O_2\\O_2\\O_2\end{matrix}\right.$$

It is clear that this tribasic alcohol must yield 3 species of ether, since if R represents the radical of an acid, 1, 2 or 3 eqs. of hydrogen in the above formula may be replaced by 1, 2 or 3 eqs. of R. Thus the three species of stearine will have the formulas,

$$\left.\begin{matrix}C_{36}H_{35}O_2\\H\\H\end{matrix}\right\}C_6H_5\left\}\begin{matrix}O_2\\O_2\\O_2\end{matrix}\right. \qquad \left.\begin{matrix}C_{36}H_{35}O_2\\C_{36}H_{35}O_2\\H\end{matrix}\right\}C_6H_5\left\}\begin{matrix}O_2\\O_2\\O_2\end{matrix}\right. \qquad \left.\begin{matrix}C_{36}H_{35}O_2\\C_{36}H_{35}O_2\\C_{36}H_{35}O_2\end{matrix}\right\}C_6H_5\left\}\begin{matrix}O_2\\O_2\\O_2\end{matrix}\right.$$

Monostearine. Distearine. Tristearine.

while there will be three chlorhydric ethers having the formulas

$$\begin{matrix}H\,C_6H_5\,O_2\\H\qquad O_2\\Cl\end{matrix} \qquad \begin{matrix}H\,C_6H_5\,O_2\\Cl\\Cl\end{matrix} \qquad \begin{matrix}C_6H_5\\Cl\\Cl\\Cl\end{matrix}$$

Monochlorhydrine. Dichlorhydrine. Trichlorhydrine.

All these combinations, as well as a triacid nitrate, a biacid sulphate and a uniacid phosphate, have been obtained already. As the radical C_6H_5 is tribasic and equivalent to 3 eqs. of hydrogen, we ought to expect an ether having the formula $\left.\begin{matrix}C_6H_5\\C_6H_5\end{matrix}\right\}\begin{matrix}O_2\\O^2\\O^2\end{matrix}$ and this has been obtained by Berthelot and Luca. In conclusion, Wurtz points out that there ought to exist 3 glyceric ammonias, in which 1, 2, or 3 eqs. of NH may be supposed to replace 1, 2, or 3 eqs. of O_2, just as ethylamine may be considered as derived from alcohol by replacing O_2 in $C_4H_6O_2$ by NH.—*Ann de Chimie et de Physique*, xliii, 492.

[Note.—It is easy to see that all the above results may be equally well explained by employing for glycerine the formula $C_6H_5O_3+3HO$, and that it is not necessary to refer it to the type of water at all. Wurtz's view is based upon Gerhardt's theory that all acids may be considered as water with a single double or treble equivalent, a certain number of equivalents of hydrogen being replaced by other radicals. We may consider glycerine with the formula $C_6H_5O_2+3HO$, as hav-

ing the same relation to alcohol with the formula C_4H_5O+HO which SbO_3+3HO bears to $KO+HO$. The 3 stearines above mentioned will have on this view the formulas $C_6H_5O_3+C_{36}H_{35}O_3$, 2HO. $C_6H_5O_3+2C_{36}H_{35}O_3$, HO. $C_6H_5O_3+3C_{36}H_{35}O_3$; while the glycerine ether of Berthelot and Luca will be $C_6H_5O_3+C_6H_5O_3$, or more simply $C_6H_5O_3$, bearing the same relation to C_4H_5O which SbO_3 bears to ZnO. We ought to expect by the action of dehydrating agents upon glycerine to obtain the body $C_6H_4O_2$, since $C_6H_5O_3$, $3HO-4HO=C_6H_4O_2$, and in like manner we should have the reactions $C_6H_5O_3$, $3HO-5HO=C_6H_3O$, and $C_6H_5O_3$, $3HO-6HO=C_6H_2$. Moreover we should have the acids $C_6H_6O_8$, and $C_6H_4O_{10}$, produced by successive substitutions of O_2 for H_2 just as acetic acid is produced from alcohol by a similar substitution.—W. G.]

3. *On some new bodies belonging to the Propionyl Series.*—Zinin has communicated the results of an investigation of the compounds of Propionyl which possess much interest and importance. It will be remembered that propionyl is the radical of propionic acid and is homologous with acetyl, its formula being C_6H_5. By the action of the iodid of this radical upon the salts of silver, Zinin has succeeded in preparing an entirely new class of ethers of which the acetate, benzoate and carbonate are described. Acetate of Propionyl $C_6H_5O+C_4H_3O_3$ (not to be confounded with acetate of propyl, $C_6H_7O+C_4H_3O_3$) is a colorless liquid, lighter than and but slightly soluble in water, but soluble in all proportions in alcohol and ether. It has a neutral reaction, a sharp odor like that of acetate of ethyl, and a sharp etherial taste: it boils at 150° C. Benzoate of propionyl is an oily liquid heavier than water and smelling like benzoic ether: its formula is $C_6H_5O+C_{14}H_5O_3$ and it boils at 242° C. Carbonate of propionyl is an oily etherial liquid lighter than water. The new ethers above described are all decomposed by contact with caustic potash either dry or in a concentrated aqueous solution. The decomposition is precisely similar to that of the corresponding ethyl compounds, the products being salts of potash and a volatile liquid soluble in water and having a faint odor but strongly attacking the lungs and eyes. The author does not give the constitution of this body, but it is doubtless the propionic aldehyde, the reaction in the case of the acetate being represented by the equation $C_6H_5O, C_4H_3O_3+KO, HO=KO, C_4H_3O_3+C_6H_5O, HO$.

The iodid of propionyl readily attacks mercury—much more easily than the iodids of methyl and ethyl. The product is the iodid of a new radical and has the formula $C_6H_5Hg_2I$; it is therefore analogous to ethyl-mercury, methyl-mercury, &c. By double decomposition with the salts of silver it gives well defined crystalline salts. Hence the analogy between propionyl and ethyl is clearly established.—*Bull. de St. Petersb.*, xiii, 360–363. *Chemisch. Pharm. Central Blatt.*, *May*, 1855.

4. *On the artificial formation of Oil of Mustard.*—Zinin has made the interesting discovery that the volatile oil of mustard is the sulphocyanid of propionyl, and that it may easily be formed artificially by distilling an alcoholic solution of sulpho-cyanid of potassium with Berthelot's iodid of propionyl. (Am. Journal Sci., xix, 270). The oily fluid which separates from the distillate on the addition of water when

redistilled gives a liquid passing over between 145° and 150°, and possessing all the physical and chemical properties of the etherial oil of mustard. The reaction is represented by the equation $C_6H_5I+KCy\ S_2=C_6H_5Cy\ S_2+KI$.—*Bull. de Petersburg quoted in Journal für prakt. Chemie*, No 8, 504, 1855.

[NOTE.—It will be remembered that the oil of mustard has long been considered as the sulphocyanid of the radical allyl C_6H_5, and that the oil of garlic is a mixture of the oxyd and sulphid of the same radical. Zinin's discovery proves the identity of allyl and propionyl, and puts it in our power to obtain artificially the oil of garlic and the very curious compounds which it forms with metallic chlorids, sulphids, &c. Thus C_6H_5I distilled with a solution of KS should give C_6H_5S and KI. I will furthermore remark that the body having the constitution $C_{12}H_{11}I$, and which may be called iodid of capronyl, must give by distillation with RS the oil of assafetida, which in a pure state appears to be simply $C_{12}H_{11}S$.

Zinin's researches have done so much toward completing the theory of the compound radicals of the acetyl type, that it is worth while to examine in this place the parallelism which exists between the acetyl and ethyl series. To do this we shall place the types of the two series in a tabular form.

Ethyl,	C_4H_5	Acetyl,	C_4H_3
Ether,	C_4H_5O	Ac. oxyd,	C_4H_3O
Alcohol,	C_4H_5O, HO	Aldehyd,	C_4H_3O, HO
Chlorid of ethyl,	C_4H_5Cl	Chl. of ac.	C_4H_3Cl
Acetate of ethyl,	$C_4H_5O, C_4H_3O_3$	Acet. of ac.	$C_4H_3O, C_4H_3O_3$
Hydruret of ethyl,	C_4H_5, H	Olefiant gas	C_4H_3H,
Ethylamin,	$N\left\{\begin{matrix}C_4H_5\\H\\H\end{matrix}\right.$	Acetylamin,	$N\left\{\begin{matrix}C_4H_3\\H\\H\end{matrix}\right.$

Tersulphid of ethyl $C_4H_5S_3$
Anhydrous acetic acid $C_4H_3O_3$.

Acetic acid $C_4H_4O_4$, and the oil of the Dutch chemists $C_4H_4Cl_2$ have no analogues in the ethyl series.—W. G.]

5. *Preparation of Metallic Lithium.*—BUNSEN has continued his investigations on the alkaline and earthy metals and has succeeded in isolating lithium upon a sufficiently large scale to admit of an accurate determination of its chemical and physical properties. Lithium is more easily prepared than the other metals belonging to the same class, and its separation forms an easy and certain lecture room experiment. Chlorid of lithium is to be fused in a small thick porcelain crucible over a Berzelius lamp and decomposed by a current of from 4 to 6 Bunsen's elements. The current passes from a point of gas-carbon through the fused chlorid to an iron wire as thick as a knitting needle. After a few seconds a small silver-white fused regulus forms and adheres to the wire gaining in a few minutes the size of a small pea. The mass is to be removed from the fused chlorid by passing under it a small iron spoon, and withdrawing the spoon and the wire electrode together so that the metal shall remain covered with a varnish of the fused

chlorid. The spoon is then to be cooled under naphtha and the metal scraped off with a penknife. As these operations may be repeated every three minutes, an ounce of chlorid of lithium may be reduced in a short time. Lithium is a white metal having the color of silver, but a freshly cut surface presently becomes yellowish from oxydation. Fused at 180° and quickly pressed up between two glass surfaces, lithium gives a mirror which perfectly resembles polished silver in color and lustre: its streak upon the touchstone is gray while that of calcium, barium, or strontium is gold-yellow. During the oxydation of this last the yellow color passes for a moment into copper red; this is not the case with calcium and barium. Lithium is a very tough metal and can easily be drawn to a wire like lead, but its tenacity is much less than that of the latter metal. Lithium fuses at 180°, is not volatile at a red heat, and can be welded at ordinary temperatures. Its density is 0·5936, and it is the lightest of all solid bodies. If we take its equivalent as 81·7 (O=100) its atomic volume is 137. Lithium is less oxydizable than sodium and potassium; it takes fire at a temperature which is far above 180° C. and burns quietly without sparks and with a white and unusually intense light. The elevation of temperature is here so great that a piece of lithium weighing only 0·005 gr. will melt a hole of 36 millimetres in a piece of mica upon which it moves with a serpentine motion. Strontium and calcium burn in a similar manner, with a yellowish light however, and not so quietly, but with sparks and a hissing noise. Lithium burns in oxygen, chlorine, bromine, carbonic acid, vapor of iodine, and upon fused sulphur, like calcium and strontium, with extraordinary brilliancy and intense white light. Upon water lithium floats and oxydizes like sodium, but without fusing. Fuming or common nitric acid oxydises lithium so violently that it often fuses and takes fire. Calcium and strontium, on the other hand, are only attacked by dilute nitric acid, but scarcely at all by it when fuming and even boiling. Muriatic and dilute sulphuric acid dissolve lithium as well as calcium and strontium, with a violent evolution of gas; concentrated sulphuric acid has however very little action in the cold. Silica, glass, and porcelain, are reduced by lithium under 200° C., but by calcium and strontium only at a red heat. The density of metallic calcium prepared from the pure chlorid, was found to be 1·5778 as a mean of three experiments: the corresponding atomic volume is 158. The density of strontium as prepared from the pure chlorid and hammered out was found to be 2·5416 which corresponds to an atomic volume of 216. The author's former statement that calcium and strontium have a white color, is inaccurate. They both show under the polishing steel, as well as when reduced at a red heat and freshly cut, a beautiful gold yellow color. With respect to hardness, the metals belonging to this class may be arranged in the following order, each being scratched by those which succeed it. Na, K, Li, Pb, Ca, S_2. The order of their electrical relations is as follows, +K Na Li Ca Sr Mg−. From this it is evident that the electro-chemical position of strontium and calcium is different from what has been supposed. The dependance of the reducing power of the galvanic current upon its density, to which Bunsen first directed attention, has been very clearly shewn in the present investigation. The best arrangement is similar to that formerly described, and consists of a porcelain cru-

cible containing a porous cell, the fused chlorid standing much higher in the cell than in the crucible. The chlorine pole is a sheet iron cylinder placed outside the cell and the metal pole an iron wire passing through an earthen pipe stem within the cell, but not reaching the bottom. The heat is to be so regulated that the upper surface of the fused chlorid in the porous cell remains solid, so that the reduced metal can collect under it without touching the cell itself.—*Ann. der Chemie und Pharmacie*, xciv, 107, *April*, 1855. W. G.

II. Mineralogy and Geology.

1. *Hunt's Wilsonite a Scapolite;* extract from a letter from E. J. Chapman to Professor Dana.—Your surmises, as expressed in the last edition of the System of Mineralogy and in your letter to me of last month, have proved to be perfectly correct. The so-called Wilsonite is undoubtedly an altered variety of scapolite, notwithstanding my former measurements and the apparently oblique cleavage of the mineral or rock-mass. Before your letter reached me, I had arrived at the conclusion, in repeating my earlier investigations, that this oblique structure arose from rock-cleavage, so to say, or, as you express it, from the presence of joints. Being determined, if possible, to set the matter at rest, I took steps to procure some large specimens of the substance; and these I have now broken up and subjected to a very close examination. I find, that besides the more facile cleavages, there are others in the same general or vertical direction, but with exceedingly variable inclinations. All of these arise from a kind of composition parallel to the principal axis; and hence the variable measurements, and the error into which I was led in considering the substance to be triclinic. The specimens at that time at my disposal were not sufficient to enable me to detect this; but it is now quite evident that the cleavage planes belong entirely to the two forms *I* and *ii*. I enclose you some small specimens on which I had marked the positions of these forms, in order that you may test the justness of my observations.* The planes *ii* are the more readily obtainable of the two, but they scarcely admit, at least so it seems to me, of satisfactory measurement, the inclination oscillating around 90°. The *I* planes, however, are smooth and pearly, and give without the slightest doubt an angle of 90°. Besides which, the inclination of *I* on *ii* equals 135° exactly, in several of the fragments that I have measured; and hence, of course, *ii* : *ii* must equal 90°. Here, then, the dimetric crystallization of the substance is fully proved, and the cleavage directions shewn to be those of Scapolite.

In illustration of what I have stated respecting composition, I may mention that I have also obtained a cleavage plane lying between *ii* and *I*, exactly in the same zone, and giving with *ii* an angle of 126° or thereabouts—an impossible angle (as being less than 135°) unless caused by composition. You may remark the peculiarity in question in one of the specimens forwarded to you with this letter; and also an instance of cross composition—using the term in a wide sense—on the back of another specimen. In this manner I have found my former angles repeated more than once.—As you are aware, I have always

* The specimens confirm the statements of Prof. Chapman.—J. D. D.

looked upon the Wilsonite as an altered species of some kind, but I thought its affinities lay more with Anorthite (or Latrobite) than with Scapolite. It yet remains to be seen, however, if the Latrobite really belongs to the Anorthite. I cannot help suspecting its identity with Wilsonite; and, as you have shewn in the last edition of your Mineralogy, interchanges between Anorthite or some of its related feldspars and Scapolite, are by no means rare: witness, Walmstedt's Tunaberg mineral, porcelain spar, glaucolite, etc.

The altered condition of the mineral necessarily precludes us from drawing any safe deductions from its composition. A few remarks may, nevertheless, be ventured upon: but I should first premise that the amount of water, together with that of the intermixed carbonate, varies to the extent of 2 or 3 p. c. in different specimens. Taking Mr. Hunt's analysis, we obtain for the oxygen ratio between the $\dot{\mathrm{A}}\mathrm{l}$ and $\ddot{\mathrm{S}}\mathrm{i}$, 3 : 5 (or nearly so)—a ratio remarkable for the high value of the first term when compared with the generality of altered scapolites; especially when potash is present as a superadded base. Take, for instance, the Algerite, the yellow Scapolite from Bolton, etc. This may perhaps justify us in considering all the other ingredients as adventitious matters, replacing the original lime; and, in that case, we obtain, with very little latitude, for the $\dot{\mathrm{C}}\mathrm{a}$, $\dot{\mathrm{A}}\mathrm{l}$, $\ddot{\mathrm{S}}\mathrm{i}$, the oxygen ratio 1 : 2·5 : 4, as given below:

		Oxygen.	Ratio.
Silica,	47·50	24·66	4
Alumina,	31·17	14·57	2·5
Lime,	21·33	6·09	1
	100·00		

This ratio, as you have shewn in your Mineralogy, II, p. 202, is common to many scapolites.

I notice that Dufrenoy in his *Traité de Minéralogie*, vol. iii, has the following observations in reference to Amphodelite, with which Latrobite is now placed:—"The specimens of Amphodelite which I have had an opportunity to study, are amorphous. Their splintery-lamellar fracture places them very near Wernerite, with which, besides, they are almost identical in composition. I should therefore have united it to this species if M. Nordenskiöld, to whom we owe the description of the mineral, had not announced that it possesses two cleavages meeting at an angle of 94° 19′, from which he concludes that its primary is an oblique rhomboidal prism. * * I should remark, however, that the cleavage of this mineral is, by no means, good; and that the angle of 94° is not far removed from a right angle, so that the two may yet be brought together."

Toronto, Canada West, July 13, 1855.

2. *On Quartz;* by M. Descloizeaux.—M. Senarmont has made a report to the Academy of Sciences of considerable length, on an admirable memoir of M. Descloizeaux on Quartz, just published, from which we here cite.—After the discovery of the rotation of polarized light by quartz, in 1813, Herschel showed its connection with the left and right-handed characters of the crystallization—indicating a general law which has since taken a position of great importance, through the labors of MM. Pasteur and Marbach. Still its application to quartz was not without some anomalies; and although these irregularities, through

the labors of Brewster, Haidinger, and especially G. Rose, have been brought under a regular law, the subject has not been exhausted. The memoir of M. Descloizeaux affords means of judging on this point.

M. Descloizeaux has examined many crystals from various localities, noting that each locality has its characteristic forms. He has made out many new planes, increasing the number of observed rhombohedrons from 13 to 60, and of plagihedral planes from 23 to 66. In the rhombohedral series, he finds only 17 which coexist with the corresponding inverse rhombohedron; and in the plagihedral series, only 8, that have also the inverse. These facts, together with the different aspect and physical properties of the faces, are regarded as proving that the fundamental form is a rhombohedron instead of a hexagonal prism.

Besides the forms mentioned, M. Descloizeaux has made out many others which appear to require to be taken into account in the study of the geometric configuration of quartz, as they are regular and well defined, yet have quite high numbers in their crystallographic expressions. It is probable that these complex forms will increase as crystallography is more studied. The study of these facts, lying on the limits of possibility in crystallography, are of peculiar interest to the science. The preponderance of the regular forces is shown to be in a weakened state, permitting the effects of external perturbative influences. The same cause accounts for the frequent imperfection of the more complex forms and the variations of angle—imperfections seldom observed among the more common forms. M. Descloizeaux has given his measurements of these exceptional cases without disguising the discordances between calculation and measurements.

The pretentions, now common with regard to the absolute exactness of crystallographic observations, leading to the use of the method of least squares for estimating the probable errors, are a pure illusion. It is easy to show that artificial crystals are altered in angle by extraneous causes, foreign to the molecular forces; and it is impossible that natural crystals should have escaped like influences. When the number of minutes is somewhat uncertain, it is not reasonable to attach so much value to seconds: a number is reached; but when the anomalies are in the nature of the thing, it is only self-deception. The divergences have causes, which are to be discovered; and it is the great problem to ascertain the limits of variation, and not blindly to assume an illusory coincidence in accordance with the abstract law of Haüy.

The new faces determined by M. Descloizeaux have much increased the possible geometric elements of hemihedrism, with which the circular polarization appears to be connected. Twenty-four plagihedral faces are now known to occur either in the right-hand or left-handed spiral. M. Descloizeaux here inquires, what particular optical effect may be connected with each of these plagihedral forms. After numerous observations, he concludes that, with one exception, the facts thus far ascertained afford no absolute conclusion, and only suggest some probable inductions.

M. Descloizeaux next takes up the macles of quartz. He shows that they often obey only approximately the absolute law of twin-composition, the angles sometimes varying 2° from the theoretical value. This shows that the forms are not held inflexibly to a geometrical law; that the physical laws express only the limits of stable equilibrium

towards which the condition always tends, but from which it may diverge considerable from external causes, without destroying altogether the equilibrium.

The subject of composition by complete interpenetration and the soldering of crystals occupies much of M. Descloizeaux's memoir. The crystals are united irregularly, almost as if melted into one another, the union being in an exceedingly complex manner. These forms were well illustrated by Mr. Gustav Rose. But M. Descloizeaux has examined them by sections in various directions, and studied both their crystalline appearances and their optical characters, finding sometimes a mosaic interior.

The various appearances are shown in the engravings. The effects of polarized light were obtained by means of photography.

Plates cut from the extremities of the same crystal have rarely the same structure, and almost always show a more or less complicated arrangement of plates of contrary rotation.

The planes of composition are usually parallel to the faces of the pyramid, more rarely to the rhombic faces of Haüy; sometimes parallel to the faces of the hexagonal prism or some very acute rhombohedron. The arrangement of quartz of inverse rotation in layers parallel to certain faces of the crystal seems at first to accord with the law of increment. But how can we explain the direction of the different colored strata, when the parts of different rotation, while being still in regular layers, cross other plates often in opposite directions? when the layers have regular contours and divide the interior of the mass into compartments with a symmetry which cannot be mere chance? Photography has been of vast service to this subject by the fidelity with which it registers the facts. The plates are numerous and of the highest interest.—*L'Institut*, No. 1117.

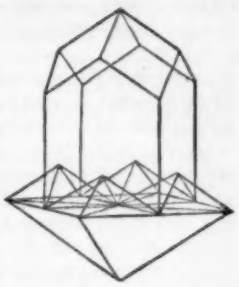
3. *Note on Heulandite and Scapolite from Arendal*, by E. Zschau. —From the chemical composition of the varieties of these minerals which occur at Arendal may be noticed an interesting analogy. The following analyses (I, II) of *Scapolite* are by von Rath, and (III) of *Heulandite* by Sjögren.

	I.	II.		III.
$\ddot{S}i$	45·05	46·82	$\ddot{S}i$	58·41
$\ddot{A}l$	25·31	26·12	$\ddot{A}l$	16·56
$\dot{F}e$	2·02	1·39	$\dot{C}a$	7·89
$\dot{C}a$	17·30	17·23	$\dot{M}g$ Mn & alkalies	0·54
$\dot{M}g$	0·30	0·26	$\dot{H}$	16·53
$\dot{K}$	1·55	0·97		
$\dot{N}a$	6·45	6·88		
$\dot{H}$	1·24	0·33		

$(\dot{C}a, \dot{N}a)^6\,\ddot{S}i^2 + 2\ddot{A}l\,\ddot{S}i$. $\qquad$ $\dot{C}a\,\ddot{S}i + \ddot{A}l\,\ddot{S}i^2 + 6\dot{H}$.

The basic nature of Scapolite and the more neutral of Stilbite point out clearly that the excess of the bases in the former has been removed by atmospherical agencies, giving as products the more neutral and stable compound, Stilbite. The alkalies of the Scapolite have entirely disappeared, as well as a large portion of the earths.

This view is supported by the fact that the Heulandite of Arendal (Barboe Mine) always occurs either upon or near Scapolite.



4. *On a Twin Composition between Malacone and Xenotime, Apatite, or Monazite;* by ERNST ZSCHAU, (communicated by G. J. BRUSH.)—It is an interesting question whether crystals of different kinds can form twins with one another. The annexed figure of an actual crystal from Hitteröe, is an example of two species thus combined, both of the dimetric system, the prism being zircon (Malacone), and the octahedral part below, Xenotime; the two are homœomorphous, $O:1$ being 138° 45′ in Xenotime, and but little less in Malacone (138° 15′).

Malacone also occurs at Hitteröe compounded with apatite and monazite. The O on 1 in apatite is 136° 47′.

5. *On Prosopite;* by GEO. J. BRUSH.—Prof. Scheerer* has shown that the so-called "Speckskein" pseudomorphs from Altenberg in Saxony, have the composition of Kaolin, and that the crystals although homœomorphs, are not pseudomorphs of Barytes as suggested by Breithaupt;—the original mineral being, according to him, a fluorid of aluminium and lime, with water, to which he has given the name Prosopite.

Subsequently Prof. Dana pointed out its homœomorphism with Datholite, and suggested that Prosopite might possibly be an altered Datholite.

Through the kindness of M. E. Zschau of Dresden, I was put in possession of a number of crystals of Prosopite, which, although presenting the same crystalline form, had such a diversity of physical characters, that I was led to give them a chemical examination, to ascertain if possible the true composition of the unaltered mineral.

Owing to the small quantity of the mineral at my command, the results obtained are for the most part incomplete.

The physical and chemical characters of the crystals were as follows: Color light violet and transparent to white and opaque. H. from 4 to so soft as to be easily scratched by the nail. Lustre brilliant to dull. The violet crystals had a hardness of 4, sp. gr. 3·177, a brilliant lustre, and a distinct octahedral cleavage; they contained no water and were composed of pure Ca Fl and a trace of organic matter. A quantitative analysis, made by decomposing with sulphuric acid, gave on 141·5 milligrammes of mineral employed, 242 milligrammes of sulphate of lime, equal to 71·44 milligrammes or 50·49 per. cent. of calcium. The result of the decomposition by sulphuric acid was completely soluble in water and the solution gave no reactions for any other base but lime. The crystals which had a less brilliant color and a diminished hardness contained more or less of a hydrous silicate of alumina according to the extent of alteration they had undergone, the results of complete alteration being pure kaolin as shown by Scheerer.

In all of the crystals that contained even traces of water, alumina was also found; and although silica was not in each case detected, there can be little doubt of its presence, as the change from fluor-spar into

* Poggendorff's Ann., xc, 315.

kaolin can be so distinctly followed. (Where fluor-spar predominated in the mineral silica might be easily overlooked as when decomposed by sulphuric acid, it would be evolved in the form of gas in combination with the fluorine. I confess I had neither apparatus nor sufficient quantity of the mineral to investigate this point as accurately as it deserved.)

This unexpected result made it of importance to determine with accuracy the form of the crystals. For this purpose all of the specimens in my possession were forwarded to Prof. Dana who has had the kindness to examine them and communicates herewith the result of his examination. The violet crystals were in some cases accompanied by massive fluor, in others imbedded in Hematite.

In connection with the above results, my attention was called to the fluor of other localities, particularly that of Zinnwald and Graupen. At Zinnwald the cubical crystals of fluor are sometimes altered into a substance resembling Speckstein; on analysis this so-called Speckstein proved to be a hydrous silicate of alumina and the partially altered crystals had the same composition as the Prosopite before examined.

With the Cassiterite at Graupen in Bohemia is found fluor-spar and a compact white mineral which has heretofore been called Speckstein. This latter is a hydrous silicate of alumina and the same stages in the passage from fluor into this substance may be observed here as have been described with the Prosopite crystals. Specimens of fluor from Nieder, Pöbel, and other localities near Altenberg presented the same peculiarities.

From these facts it seems that fluor-spar is liable to alteration into kaolin, and that much of the so-called Speckstein is really a hydrous silicate of alumina.

I regret that it is not in my power to give a series of quantitative analyses showing the gradual passage of the fluor into kaolin, and I only offer this brief notice of my results in the hope that it may be the means of calling the attention of some chemist to the subject who may have an abundance of the mineral and a laboratory at his command.

Freiberg, July 16, 1855.

Note by J. D. Dana.—I have examined the crystals of Prosopite sent me by Mr. Brush, and find the external characters and cleavage confirming fully his statements. The form presented, is well shown in the figure in my Mineralogy, 4th ed., p. 502, (here repeated) which is drawn from Scheerer's but in an altered position, and there is little variation either by distortion or otherwise. It is hemihedral trimetric, like Datholite. I have endeavored to reconcile the form with a distorted monometric crystal; but the persistence and regularity of the form in all the crystals, is against the idea of its being a distortion. Moreover, if a twin, composition must be parallel to $\breve{a}\breve{i}$; and this view is opposed by the inclination of $\breve{a}\breve{i}$ to the planes around it, and still more by the cleavage, which cuts through the crystals without any reëntering angle or line of interruption. The cleavage affords in fact regular tetrahedrons and octahedrons with the same facility as fluor spar; and no one of the faces of cleavage in one crystal was

parallel to $i\breve{i}$, or to any other occurring plane. Moreover the cleavage planes had no symmetrical arrangement with reference to the axes of symmetry in the crystal.

Although, therefore, the violet crystals are monometric fluor spar in cleavage and other characters, I am not satisfied that the external form is monometric in origin; it may be pseudomorphous after some species not yet ascertained.

Several of the crystals have the edge between the two planes $i\breve{2}$ beveled by two planes I, which according to my measurements, (approximations only, as the faces do not reflect a distinct image and are often uneven,) incline to one another, 113° 30′. I obtained also $i\breve{2} : i\breve{2} = 74°\ 30'$, $I : i\breve{2} = 150°\ 45'$; $i\breve{i} : x$ (unlettered plane) 104° 30′; $2:2 = 131°$ in one crystal; 133° — 134° in another; (and the latter crystal afforded also $2\breve{i} : 2\breve{i} = 118°\ 15'$.) In one specimen there is a plane replacing the edge $i\breve{i} : 2\breve{i}$, giving for the inclination on $2\breve{i}$ approximately 149° 30′; it is probably the plane $6\breve{i}$, following the lettering in the figure. The plane $2\breve{3}$ is usually uneven; and there is sometimes another between it and $2\breve{i}$.

One of the Prosopite crystals is violet fluor at one extremity and white like a kaolin at the other.

6. *Note on Geology of country East of Cascade Mountains, Oregon*, (extract of a letter from Geo. Gibbs, Esq. dated Steilacoom, Washington Territory, May 7th, 1855).—Dr. George Suckley, Assistant Surgeon U. S. A., stationed at the Dalles of the Columbia, Oregon, has recently made an important discovery bearing upon the geology of the country east of the Cascade mountains, of which, although the details are as yet but imperfectly ascertained, we think a notice will prove interesting. It is the existence of extensive strata of fossiliferous limestone lying between beds of basalt. The limestone appears to be protected in places by a layer of river stones and gravel, and elsewhere to be metamorphic. The order of position descending is as follows. 1st. Sand and superficial soil 1 to 10 feet; 2nd, basaltic rock 3 to 10: 3d, cobblestone and pebbles; 4th, limestone 6 to 8 feet; 5th, cobble stones, &c.; 6th, basalt. Among the fossils are bones of mammalia, some of them gigantic. They are brittle and require great care in removing, and as yet no examinations have been made to ascertain their genera. These bones are also found near Fort Wala-wala, at the junction of the Snake and Columbia and are said by the Indians to be common there. No fossiliferous rock has heretofore, it is believed, been found in any place between the Blue Mountains and the Cascades and the rarity of organic remains, in that region has been the subject of remark. This discovery will throw much light on the character of the interior sea which once occupied that basin.

7. *Statistics of Coal*, including Mineral Bituminous Substances employed in Arts and Manufactures; with their Geographical, Geological and Commercial Distribution, and amount of Production and Consumption on the American Continent, with Incidental Statistics of the Iron Manufacture, by R. C. Taylor, F.G.S. London, etc., etc. 2nd edition. Revised and brought down to 1854, by S. S. Haldeman, Prof. Nat. Sci. and Agric. in Delaware College, &c. 640 pp. 8vo, with maps, plates, and numerous wood-cuts. Philadelphia, 1845: J. W. Moore.—The first edition of this work was issued in 1848. Since that time the able

author, Mr. R. C. Taylor has died, and this second edition has been brought up to the present time under the supervision and labors of Prof. Haldeman. The original work was a vast repository of knowledge on the subject of Coal, both scientific, practical, and commercial, a result of extensive personal knowledge of Coal mines and Coal, as well as of the literature of the subject. Moreover the subject of iron, particularly the iron trade—as it is so often a part of the industry of a coal region—came in incidentally and added greatly to the useful character of the work. In preparing the new edition, the work has been rendered more especially American, by enlarging the American part both with respect to the subjects of Coal and Iron, while the chapters treating specially of other parts of the world, have been omitted. These additions have been made with care and fullness, and the work is in itself a library on Coal, Coal Formations, all kinds of combustible materials in the earth, Coal mines and Mining, while it also contains much information on Iron, Iron furnaces, and the iron productions of different parts of the country and the world. New maps on the Coal formations of Iowa, Wisconsin, Illinois and Alabama have been added from the publications of Dr. Owen and Prof. Tuomey.

III. Botany.

1. *Sexual reproduction in the Lower Cryptogamia.*—The reprint of Henfrey's Report in the numbers of this Journal for January and March, 1853, followed in the May number (p. 455) by references to later investigations, brings down to a comparatively recent date the history of discovery in this important department of physiology. M. Thuret has continued his researches upon the fecundation of the *Algæ*, and, in Annales des Sciences Naturelles, vol. ii, No. 4 of the fourth series, announces that he has obtained direct proof of the impregnation of the spores by the antheridia in the common *Fucus vesiculosus* and other *diœcious* species, which on this account offer the best facilities for the investigation. The *octospores* having escaped from the conceptacles of the mother-plant, the 8 contained spores soon escape from the dissolving epispore, and from an extremely delicate membrane which Thuret finds within the latter. When they thus become free in the water (which they do within an hour or less after the octospores are shed from the conceptacles), the spores are round, olive-yellow bodies, entirely destitute of any integument; but after some hours a membrane of cellulose begins to form on their surface. In experiments upon these diœcious species the spores may be submitted to the action of the *antherozoides*, so abundantly shed from the antheridia of the male plants, which move free and spontaneously in the water with such vivacity, and which in this case come into direct contact with the naked spores;—or the latter may be kept separate from the former. In the first case *the spores are fecundated and germinate: in the second, they do not germinate at all.* On placing the spores in water containing some antheridia, the *antherozoides* were seen under the microscope to attach themselves in great numbers to the surface of a spore, and even to communicate to it a rapid rotatory movement, lasting for about half an hour,—which movement, as Thuret satisfied himself, was caused solely by the conjoint action of the

vibratile cilia of the attached *antherozoides*. The latter continue their usual movement, though with diminished vivacity, for some time after the spore comes to rest. The next day after the spores had been in contact with the *antherozoides* they were found to be clothed with a membrane of cellulose; and on the same or the following day, or sometimes later, the first partition appeared, dividing the spore into two cells; one of these began to form a slight protuberance at a point perpendicular to the partition, which soon elongated into a hyaline slender filament,—a sort of radicle, by which the germinating plantlet is attached,—while the cell at the opposite extremity enlarges and divides to produce the rudimentary frond. On the other hand, spores under the same circumstances, except that they were kept separate from the antheridia, remain unchanged for several days, and then are decomposed, or else they become covered with a cellulose coat and then make some abortive attempts at germination, but end by undergoing decomposition within ten or fifteen days. Having repeated these experiments many times upon all the diœcious species of the coast of Normandy, always with the same result, Thuret announces it as an ascertained fact, that the spores of *Fucaceæ* are incapable of germinating and of reproducing the species without the concurrence of the *antherozoides*. Moreover, no germinations could be produced when the spores of one species were mingled with the *antherozoides* of another of the same or of an allied genus,—showing the usual reluctance to hybridism;—except in the case of spores of *Fucus vesiculosus* mixed with the *antherozoides* of *F. serratus*, when germination readily took place; but the supposed hybrids, though well developed up to a certain stage, were not brought to perfection so that their character could be demonstrated. The striking resemblance of this whole process to that of fecundation in animals will not fail to be noticed. To the question whether the *antherozoides* penetrate into the interior of the naked spore, Thuret answers that nothing authorises him to think so, as he has never found any evidence of such penetration; while in certain species he has proof that the spores were fecundated by *antherozoides* which were arrested by a mucilaginous external coating produced by the dissolution of the epispore or otherwise.

In a second part of this memoir, published in Ann. Sci. Nat., ser. 4, vol. iii, No. 1, M. Thuret gives the result of his continued observations upon the fructification of the Florideous Algæ. In these, the antheridia, (which were first discovered by Ellis in 1757), have now been detected in the greater part of the species of all the principal groups; but the contained corpuscles analogous to the active *antherozoides* of the *Fucaceæ*, are not found to exhibit spontaneous movement, nor to be furnished with cilia or other locomotive organs. Probably antheridia exist in all these plants. Their general occurrence, and their position and structure seem to indicate their function. But while their mode of action is not known by observation, Thuret has ascertained that the spores may and often do germinate without any contact with the corpuscles.

Still later (as we learn from an abstract given by Henfrey, in Ann. and Mag. Nat. Hist. for May last), Dr. Pringsheim, of Berlin, has discovered *antherozoides* or *spermatozoids* in *Sphacelaria* and *Cladostephus*, resembling the corpuscles of *Florideæ* in form, but furnished with two

cilia like those of the *Fucaceæ*, and moving actively in the same manner. His observations upon the fecundation of *Fucus vesiculosus* confirm those of Thuret. Dr. Pringsheim has also found indications of bisexual reproduction in the green fresh-water *Algæ;* and in *Vaucheria* he thinks he has confirmed Vaucher's original idea that the 'horns' perform the function of anthers. These, according to his researches, are really antheridia, their contents being converted into minute vesicles, the $\frac{1}{1000}$ of a line in diameter, furnished with two unequal cilia, by which, when set free by the bursting of the horn at the apex, they move rapidly in all directions, "great numbers (twenty, thirty or more) making their way into the opening of the spore-fruit, and coming into contact with the tough mucilaginous layer bounding the contents. After a time a distinct membrane appears all over the mass of contents of the spore-fruit, converting it into a free cell (the spore); and the author states that he several times saw a largeish, colorless corpuscle inside the mucilaginous coat of the contents; he believes this to have been a spermatozoid which had penetrated into the mass. The process as here described is therefore the impregnation of a mass of contents by a spermatozoid, and a subsequent formation of the cell-membrane of the spore." Pringsheim maintains here, and in a recent memoir on the structure of the cell in plants, that the primordial utricle of Mohl, the protoplasmic layer, does not cause the coat of cellulose or permanent cell-wall to be formed upon its surface, as Mohl maintains, but becomes actually transformed into the cellulose coat! We wait to learn how Mohl will regard this view. A. G.

2. *Trécul; Formations Secondaires dans les Cellules Végétales.*—An elaborate memoir, in Ann. Sci. Nat., ser. 4, vol. ii, illustrated by numerous figures, of which the principal conclusions are; that the vegetable cell can produce secondary formations or deposits on the outside as well as the inside of the primary membrane; some thickening in one way, some in the other, and some in both ways; that the spiricules, reticulations, rings, &c., are originated by the primary membrane which precedes them, and that they are *hollow;* that in the case of some vessels or cells composed of three zones, as in *Taxus*, the intermediate zone is the youngest; that, consequently, the secondary membranes are not due to sedimentary matters deposited by the liquids contained in the cells; and that the cavities of contiguous wood-cells communicate by real perforations of their parieties. A. G.

3. *Mohl on Chlorophyll.*—An article in the *Botanische Zeitung*, for February last, is reproduced by Henfrey, in an English translation, in Ann. and Mag. Nat. Hist. for May and June, 1855. With the thoroughness which characterises Prof. Mohl's researches, he first combats, apparently with complete success, Nageli's view of the utricular nature of chlorophyll-granules, showing that they have no investing membrane distinct from the contents, still less a cellulose coat comparable with the cell-membrane. He still believes that the grains of chlorophyll do not belong to the ternary series of products at all, but consist of a soft proteinous substance, related to albumen, in which in most cases one or more starch-grains are imbedded, and which owes its green hue to the presence of an extremely small quantity of green coloring matter, seemingly deposited only or principally in its outer layer. By demon-

strating the occurrence of chlorophyll in cells which contained no starch, or the growth of the green globules after the starch-grains have vanished, and in other cases the simultaneous increase of starch and chlorophyll grains in the same cells, Mohl has shown the groundlessness of Mulder's hypothesis, that chlorophyll is formed of starch altered by deoxydation, and that the evolution of oxygen by green foliage is merely the result of this supposed transformation of starch into green coloring matter and wax; and he maintains that, by appropriate evidence, he has abundantly demonstrated the principal mass of chlorophyll-grains to consist of a substance allied to protoplasm, which certainly cannot originate from a metamorphosis of the constituents of starch. A. G.

4. *The Seeds of Magnolia.*—In a paper read before the Linnæan Society in November last (of which an abstract is given in *Ann. and Mag. Nat. Hist.* for May last), Mr. Miers is led to question the view taken in the *Genera of N. Am. Plants Illustrated*, viz, that the fleshy integument of the seed of Magnolia is a proper seed-coat, arising from the external coat of the ovule; and, indeed, he insists that it is an *arillus*, or in other words an accessory covering, not found in the ovule but formed at a later period. A careful re-investigation of the ovules and seeds in a fresh state enables us positively to state that the latter supposition is incorrect; that no accessory covering is formed over the ovule or seed; that the outer coat of the former, which is thick and fleshy from the first, and has the vessels of the rhaphe imbedded in it, thickening still more as the seed grows, becomes the red fleshy envelope, while a series of new cells formed on its inner face, and elongating transversely as they multiply by division, gives rise to the crustaceous integument; the inner coat of the ovule meanwhile remaining thin, and forming a delicate membrane more or less closely adherent to the albumen. Mr. Miers' view, therefore, is correct only as respects the innermost covering of the seed. A. G.

5. *Bertoloni: Miscellanea Botanica*, fasc. 13 & 14. Bologna, 1853.—These fasciculi contain each an academical lecture, and the characters of a few supposed new species of plants. In the 13th, as in several former fasciculi, the materials are unfortunately furnished by a set of the specimens collected many years ago in Alabama by Dr. Gates, and distributed to subscribers. We enumerate the seven plants here named, described, and figured, to show what Signor Bertoloni makes of them.

(1.) His *Nicotiana humilis*, a new species with opposite leaves! is *Dipteracanthus ciliosus*, Nees.

(2.) *Persea longipeda*, of which the author may truly say, "Non reperio inter Perseas hactenus evulgatas," since it is evidently *Chrysobalanus oblongifolius*.

(3.) *Trichostemma linariæfolium*, is luckily of the right family and genus: it is *T. lineare*, Nutt.

(4.) *Dasystoma tubulosa* is *Macranthera fuschioides*, Torr.

(5.) *Hypericum punctulosum* is *H. cistifolium*, Lam. (*H. opacum*, Torr. & Gr.)

(6.) *Ascyrum Plumieri* is *A. Crux-Andreæ*, Lin.

(7.) *Empetrum aciculare* is *Ceratiola ericoides*, Michx. A. G.

6. *Prof. Braun*; "*On the oblique direction of the ligneous fibre, and the twist of the trunks of trees occasioned thereby*;" read before the Academy of Sciences at Berlin, and published in its Proceedings.—This twist of the wood of many trees is a phenomenon well known to wood-cutters, shingle-makers, carpenters, and others, but almost entirely neglected by botanists. The distinguished geologist, the late Leopold von Buch, appears to have first directed the attention of scientific men to it; and De Candolle, in his *Organographie* (1827) was the first botanist who spoke of it. Little has since been done to substantiate or elucidate the phenomenon. In the pamphlet before us Prof. Braun gives the result of a great many observations made by himself in Germany, by his brother in France and Spain, and by the writer of this notice in the Mississippi Valley.

Most trees show this obliquity of the woody fibre more or less. In certain species the twist is almost uniformly in the same direction: in others both directions occur with about equal frequency; while in not a few no twist is distinctly observable. Sometimes the same direction prevails in the majority of the species of a genus, or even of a whole family: in other cases opposite directions occur in the same genus or family; and it is curious to remark that in some instances nearly allied species of Europe and America twist in opposite directions. In a few instances the fibre of a young tree is twisted in one direction; that of the old tree in the opposite direction.

In speaking of the direction, it is necessary to come to an understanding, first of all, as to what we mean by right or left, a distinction attended with more difficulty than would appear possible. Prof. Braun follows De Candolle and others in viewing the twist or coil objectively; imagining himself in the centre of the coil. Thus viewed, the bean-vine turns to the *left*, the hop-vine to the *right*, &c. Linnæus and others, however, have adopted the opposite, or subjective view, and regard the bean and other leguminous plants as turning to the right, as they appear to an observer standing before the coil.

The twist of the fibre may be discerned in splitting the wood, or in its cracks when the bark is stripped off, or in the course of the fissures made by lightning. Very often the bark itself, at the angles or superficial lines of the trunk, indicate the direction of the wood within very distinctly. We make a few extracts from 167 species observed.

No manifest twist has been observed in species of *Fagus*, *Juglans*, and *Carya*, either in Europe or America, nor in *Ulmus*, *Ailanthus*, *Fraxinus*, *Acer dasycarpum*, *Gleditschia* or *Robinia*, though the latter exhibits a very slight twist to the left. The woody fibre twists to the right in *Pinus Strobus*, *Ostrya Virginica*, the Chestnut of Europe, the European and American *Salices*, *Populus pyramidalis*, *Cornus Florida*, *Liriodendron* (in Indiana and Illinois, though in cultivated specimens the twist was found to be the other way; but more observations are required), the Peach, Plum, and Cherry trees, and in the European *Cercis Siliquastrum*, the only Leguminous tree known to twist to the right. The twist to the left hand is the more common: it occurs in most *Coniferæ*, especially in *Juniperus Virginiana*, *Taxodium distichum*, *Pinus sylvestris* (of which young trees twist, however, in the opposite direction), *Picea excelsa*, &c., *Betula* and *Alnus*, *Ostrya vul-*

garis and *Castanea Americana* (both in opposite direction to the nearly allied species of the Old World), *Quercus Robur*, *Populus angulata*, *Catalpa*, *Æsculus Hippocastanum*, the Pear tree, and more than any other the Pomegranate, also most Leguminous trees.

Most American Oaks, the Sassafras, *Acer nigrum*, the Apple-tree, &c., twist about as often to the right as to the left.

The cause of the apparent twisting is not easily ascertained. It is not occasioned by an actual twisting of the whole stem, but belongs to the growth of the successive annual layers. Prof. Braun connects it with the growth of the wood-cells, of which the ends, at their formation are horizontal or nearly horizontal, become wedge-shaped as they elongate; and if these wedges assume the same direction in the whole circumference of the stem, as they are apt to do, the wood-cells would assume a certain obliquity; so that this twist of the wood is connected with the intimate nature or disposition of the cells themselves. But this is not sufficient to explain the higher grades of the obliquity, which sometimes reaches an angle of 45 degrees. It would here be desirable to ascertain whether the cambium cells divide in this oblique direction and high angle.* Any one who may take an interest in these investigations is requested to institute observations and make memoranda, noting the number of trees observed, as well as the direction and angle of the twist observed, if any. G. E.

7. *The Wellingtonia of Lindley.*—In a communication to the Botanical Society of France in June, 1854,† M. Decaisne has confirmed the view which we had suggested, in this Journal and elsewhere, that the gigantic Coniferous tree to which Dr. Lindley gave the name of *Wellingtonia gigantea* is nothing more than a second species of *Red-wood* or *Sequoia*, which must therefore bear the name *S. gigantea*. Decaisne justly observes that two forms of foliage occur in a more or less marked manner in most *Coniferæ*, not excepting the *Sequoia sempervirens*, which on the same branch often presents both imbricated and distichous leaves;—that in the structure of the fruit and seeds the common Red-wood and the so-called *Wellingtonia* are identical, the only difference being that the cones of the latter are larger;—that the structure is not like that of *Sciadopitys*;—and finally, that the wood of the two trees is similar, both abounding with the red coloring matter, soluble in water, from which the Red-wood takes its name. M. Decaisne, however, appears not to have seen the male flowers, which, as we formerly remarked, are alone wanting to confirm the perfect generic identity of *Wellingtonia* with *Sequoia*.

From M. Boursier de la Rivière, the French consul in California, M. Decaisne has likewise received specimens of a new California Conifer,

* Our common Tupelo, or Pepperidge, or *Nyssa* would be a good subject for the investigation, since the obliquity of its wood is generally very considerable, and the layers of a certain number of years incline in the opposite direction from those of the preceding layers. A. G.

† *Bulletin de la Société Botanique de France, fondée le 23 Avril*, 1854. Vol. 1, No. 2, p. 72.—This is published in monthly numbers, each of 44 to 60 pages, 8vo. We have received the first volume and two fascicles of the second of this publication, and find it full of interesting matter, showing the great activity and ability with which this Society has begun its work. M. Brongniart was the first President, and was succeeded by M. Decaisne for the current year.

which he refers to *Chamæcyparis*, and names *C. Boursieri*, distinguished by its short leaves, very closely imbricated, oval, acuminate leaves, furnished with a gland about the middle.

Decaisne distinguishes from our *Taxodium* the Mexican tree, under the name of *Taxodium Montezumæ*. A. G.

8. *Does Sea-water kill Seeds?*—A question which has an important bearing upon the actual or possible dispersion of many species over the large geographical area which they are found to occupy, and therefore upon the problem whether the same organic being was created at one point, or at several or many widely separated points, on the face of the globe. It is commonly believed and stated that seeds—those of maritime plants excepted—will not germinate after exposure to salt water: and so general is the belief, that no one, so far as we know, has made the experiment until now, when the distinguished naturalist, Mr. Darwin, has shown that seeds of various kinds will germinate promptly after prolonged immersion in sea water. The account of his simple but well-devised experiments is given in the London *Gardeners' Chronicle* for May 26th, 1855. We copy the principal part of it.

"As I had not the least notion when I began, whether or not the seeds would be all killed by a single week's immersion, I at first took only a few, selecting them almost by chance from the different great natural families; but I am now trying a set chosen on philosophical principles, by the kindness of Dr. Hooker.

"The sea-water has been made artificially with salt procured from Mr. Bolton, 146, Holborn Bars, which has been tested by better chemists than men, namely, by numerous sea animals and algæ having lived in it for more than a year. The seeds were placed in separate bottles, holding from two to four ounces each, out of doors in the shade: the mean temperature has during the period been about 44°, rising during one week to a mean of nearly 48°. Most of the seeds swelled in the water, and some of them slightly colored it, and each kind gave to it its own peculiar and strong odor. The water in which the Cabbage and Radish seeds were placed became putrid, and smelt offensively in a quite extraordinary degree; and it is surprising that any seeds, as was the case with the Radish, could have resisted so contaminating an influence; as the water became putrid before I had thought of this contingency, it was not, and has never been, renewed. I also placed seeds in a quart bottle in a tank filled with snow and water, to ascertain whether the seeds kept at the temperature of 32° would better resist the salt water; this water, like that in the small bottles, to my surprise, became turbid and smelt rather offensively. In the following list I have no reason to suppose, except in the cases where so stated, that the seeds have endured their full time.

"(1) Seeds of common Cress (Lepidium sativum) have germinated well after 42 days' immersion; they give out a surprising quantity of slime so as to cohere in a mass. (2) Radishes have germinated less well after the same period. (3) Cabbage seed: after 14 days' immersion only one seed out of many came up; I think this is rather strange considering that the cabbage is a sea-side plant; in the ice-cold salt water, however, several have come up after 30 days' immersion. (4) Lettuce seed has grown well after 42 days; (5) of Onion seed only a

few have germinated after the same period; (6) Carrot and (7) Celery seed well after the 42 days; (8) Borago officinalis, (9) Capsicum, (10) Cucurbita ovifera, have germinated well after 28 days' immersion; the two latter, rather tender kinds, were also tried in the ice-cold water, and have germinated after 30 days' immersion. (11) Savory, or Satureja, has grown somewhat less well after 28 days. (12) Linum usitatissimum: only one seed out of a mass of seeds (which gave out much slime) came up after the 28 days, and the same thing happened after 14 days; and only three seeds came up after the first seven days' immersion, yet the seed was very good. (13) Rhubarb, (14) Beet, (15) Orach, or Atriplex, (16) Oats, (17) Barley, (18) Phalaris Canariensis, have all germinated excellently after 28 days; likewise these six latter after 30 days in the ice-cold water. (19) Beans, and (20) Furze or Ulex: of these a few survived with difficulty 14 days; the Beans were all killed by 30 days in the ice-cold water. (21) Peas germinated after seven days, but were all dead after 14 days' immersion out of doors, and likewise after 30 days in the ice-cold water. (22) Trifolium incarnatum is the only plant of which every seed has been killed by seven day's immersion; nor did it withstand 30 days in the ice-cold salt water. (23) Kidney Beans have been tried only in the latter water, and all were dead after the 30 days.

"As out of these 23 kinds of seed, selected almost at hap-hazard, the five Leguminosæ alone have as yet been killed (with the exception of the Cabbage seed, and these have survived in the ice-cold water), one is tempted to infer that the seeds of this family must generally withstand salt water much worse than the seeds of the other great natural families; yet, from remarks in botanical works, I had expected that these would have survived longest. It has been really curious to observe how uniform, even to a day, the germination has been in almost every kind of seed, when taken week after week out of the salt water, and likewise when compared with the same seeds not salted—all of course having been grown under the same circumstances, namely, in glasses on my chimney-piece, so that the seeds from the day of being planted have been always under my eye. The germination of the Rhubarb and Celery alone has been in a marked degree altered, having been accelerated. With respect to Convolvulus tricolor, not included in the above list, I may mention that many of the seeds germinated and came out of their husks, while still in the salt water, after six or seven days' immersion.

"To return to the subject of transportal, I may state that in 'Johnston's Physical Atlas' the rates of 10 distinct currents in the Atlantic (excluding drift currents) are given, and the average of them is 33 nautical miles per diem; hence in 42 days, which length of immersion seven out of the eight kinds of seed as yet tested have already stood, a seed might be readily carried between 1300 and 1400 miles.

"I will conclude this too lengthy communication by observing that all the 40 to 50 seeds which I have as yet tried sink in sea-water: this seems at first a fatal obstacle to the dissemination of plants by sea currents; but it may be doubted whether most seeds (with the exception of the winged kinds), when once shed, are so likely to get washed into the sea as are whole or nearly whole plants with their fruit, by

being carried down rivers during floods, by water-spouts, whirlwinds, slips of river-cliffs, &c., continued during the long lapse of geologically modern ages. It should be borne in mind how beautifully pods, capsules, &c., and even the fully expanded heads of the Compositæ, close when wetted, as if for the very purpose of carrying the seed safe to land. When landed high up by the tides and waves, and perhaps driven a little inland by the first inshore gale, the pods, &c., will dry, and opening will shed their seed; and these will then be ready for all the many means of disposal by which Nature sows her broad fields, and which have excited the admiration of every observer. But when the seed is sown in its new home, then, as I believe, comes the ordeal; will the old occupants in the great struggle for life allow the new and solitary immigrant room and sustenance?"

It would be well to submit to this experiment the seeds of a considerable number of those very species which naturally occur in two or more widely separated areas. And also to take the seeds of indigenous individuals, rather than of those of long-cultivated plants, which last certainly possess augmented vegetative power, though perhaps they may not offer increased resistance to the action of salt water.

We have just learned from Mr. Darwin that some of these seeds have germinated after 82 and 85 days' immersion in sea-water, namely, those of Radishes, Beet, Atriplex, Capsicum, Oats, Cucurbita, Rhubarb, Lettuce, Carrot, Celery, and Onions. A. G.

9. *Ravenel; Fungi Caroliniani Exsiccati.* Fasciculus III. John Russell, Charleston, S. C. 1855.—This fasciculus appears to be an improvement on the preceding ones, especially in its almost entire exemption from typographical errors, by which the others are so much defaced. The index has a much neater appearance. The specimens are generally good, and in sufficient quantity for illustrating the species. Foreign purchasers will be pleased to find so large a proportion (this century contains over sixty) of species peculiarly American. Many of these were never before published. Several fine species have been furnished from beyond the limits of Carolina; as the pretty *Aregma speciosum*, Fr., by Dr. Sartwell of New York; *Bulgaria rufa*, Schw., by Dr. Michener of Pennsylvania; a new *Cladosporium* by Mr. Beaumont of Alabama; the fine *Stereum pergameneum*, Berk. & Curt., and *Xylaria Œdipus*, Mont., &c., by Hon. T. M. Peters of the same State. This latter gentleman has been particularly successful in the discovery of new species of cryptogamic plants, thus supplying a new instance of what can be done for the advancement of science in the leisure intervals of professional life. Mr. Ravenel has himself given several fine forms of *Corticium* and *Sphæriceæ*; a new genus RAVENELIA, founded on the *Sphæria epiphylla*, Schwein., of which Mr. Berkeley has sent us a second species from India, and two very pretty epiphytes growing upon Toxicodendron, viz: *Uredo Toxicodendri*, Berk. & Rav., and *Pileolaria brevipes*, B. & R. This last has a very suspicious affinity to *Uromyces*, and unless some character more important than the length of its pedicel should be found to distinguish *Pileolaria*, this new species will present a good reason for uniting the two genera.

We have not made any critical examination of the species in this Fasciculus, but we should judge that there would be little need of future correction. *Polyporus dealbatus*, n. sp., does not seem to be the plant upon which that name was originally imposed, but agrees with what we have in our collection as *P. luteus*, Nees. *Sphæria elongata* is a species of *Valsa*, an error too extreme to be accounted for but on the supposition of extreme carelessness. But as these two errors exist in the volume through Mr. Ravenel's too great reliance upon ourself, we will share their responsibility with him. M. A. C.

IV. Astronomy.

1. *Comet*, 1855, II, (Astron. Journal, No. 85).—A new comet was discovered at Florence on the third of June last, by Dr. Donati. It was also seen the next day at Göttingen by Dr. Klinkerfues, and at Paris by Mr. Dien. Dr. Donati was unable to detect nucleus or tail, and estimated it as fainter than the nebula in *Hercules*.

From the observations at Berlin, June 5, 6, 7, Mr. Bruhns has computed the following elements:

Perihelion passage, 1855, May 29, 23896, Berlin M. T.	
Long. perihelion, - - -	240° 15′ 18.″4
" asc. node, - - -	260 52 43·1
Inclination, - - -	22 58 27·1
Log. q, - - - -	9·745678
Motion retrograde,	

2. *Report on the Shooting Stars of August 9th and 10th*, 1855; by Edward C. Herrick.—The following observations made at New Haven, Connecticut, show that the meteoric display of August has occurred this year with the usual characteristics.

The evening of Thursday, August 9, was clear and beautiful. Between $10^h\ 25^m$ P. M. of the 9th and $2^h\ 30^m$ A. M. of the 10th, *three hundred and eighty-five* different shooting stars were noted by three observers, viz, Prof. Alex. C. Twining, Mr. Christopher D. Seropyan and myself.

Many of these meteors were brilliant, and about four-fifths of all were conformable to the usual apparent radiant, or point of divergence, near the cluster in the *sword-handle* of Perseus. The following table shows the number of meteors seen per hour in the different parts of the sky, and also the number of those which were conformable to the radiant:

$10^h\ 25^m$ to 11^h P. M.,	E.	18, of which	12 conformable.
	S. W.	14	7
	N. N. W.	17	12
		— 49	— 31
11^h to midnight,	E.	37	27
	S. W.	26	22
	N. N. W.	16	13
		— 79	— 62

Midn. to 1h A. M. (10th),	E.	42	37 *c.*
	S. W.	30	27
	N. N. W.	26	22
		— 98	— 86
1h to 2h	E.	53	44
	S. W.	26	24
	N. N. W.	31	24
		— 110	— 92
2h to 2h 30m	E.	22	16
	S. W.	14	10
	N. N. W.	13	9
		— 49	— 35

During the night of Friday, the 10th, the sky was somewhat embarrassed by clouds during the whole period, about one-sixth part being on an average obscured. Observers: Prof. Alexander C. Twining, Mr. Francis Bradley, Mr. Ch. D. Seropyan. Different meteors seen, *two hundred and ninety*, as follows:

10h 30m to 11h P. M.,	N. N. E.	11, of which 7 conformable.	
	W.	19	14
	S. E.	15	14
		— 45	— 35
11h to midn.,	N. N. E.	40	34
	W.	34	27
	S. E.	35	26
		— 109	— 87
Midn. to 1h A. M. (11th),	N. N. E.	53	47
	W.	32	26
	S. E.	51	47
		— 136	— 120

The night of the 11th was clear. Mr. Bradley, watching alone, looking chiefly towards the N. and E., observed *thirty-seven* meteors in the hour from 10 to 11 P. M., about half of which were conformable. Professor Twining watching alone, and having the sword-handle of Perseus in the centre of his field of view, observed from 1h 55m to 3h A. M. of the 12th, *fifty-eight* meteors, of which forty-five were conformable. The visible courses were shorter than on the two previous nights, and fewer trains were left.

The night of the 12th was also clear. Prof. Twining, watching alone, from 1h 30m to 2h 45m A. M. of 13th, observed *thirty-six* meteors, of which twenty appeared to diverge from the constellation Perseus, and eight from some point near the zenith.

Tuesday night (14th) was nearly clear. Between 1h 10m and 2h 10m A. M. (15th) observations were made by myself with Charles C. Herrick, and *thirty-three* different shooting stars were seen, viz, 16 in N. N. E. and 17 in the west. Of these most were so remote that the place of the radiant could not be well determined. Of a few the divergent point

was about a degree vertically above the cluster in the sword-handle of Perseus, and many of the others were generally conformable to that vicinity.

On the same morning Prof. Twining observed *sixteen* meteors, from $3^h\ 8^m$ to $3^h\ 40^m$ A. M.

On the night of the 9th, the place of the radiant, or centre of the area in which the visible paths of the meteors traced back would intersect, was in my judgment about R. A. 35°, North decl. 56°.

The position of this point among the stars seems to have undergone no very certain change since 1837 and 1838, before which it was not so well ascertained.

From about midnight onward we saw on the first night of observation, (9th), a faint light hardly a degree high, along the northern horizon, which we supposed might be the Aurora Borealis. At 1 A. M. this appearance was not discernible in the North, but the Zodiacal Light was then becoming apparent in the N. N. E., although its outlines could hardly be determined. By 2 A. M. the Zodiacal Light was quite conspicuous, yet ill defined, appearing in position and extent as at this period in former years.

A faint illumination of the Northern horizon was also observed on the night of the 10th, but on account of clouds its character could not be certainly determined.

New Haven, August, 1855.

V. Miscellaneous Intelligence.

1. *The Smithsonian Institution.—Note.*—In our article upon this Institution, in the July number of the Journal, on p. 10, we find that we have unintentionally done injustice to the views and consistent course of action of the Hon. J. A. Pearce, of the U. S. Senate;—having been misled by placing a reliance on the correctness of certain statements in "Mr. Meacham's Report," (p. 258,) which, it appears, we ought not to have done.

It certainly involves no unfavorable implication that a person should change his mind on further experience, and under a change of circumstances. And, assuming the full correctness of Mr. Meacham's account, our object was to show 1st, how naturally and properly a Senator might have advocated in Congress "the library plan," in preference to any other then proposed, and afterwards, as a Regent, cordially sustain the plan of operations actually adopted: and 2nd, that the doing so clearly proved that he did not understand the law as it passed to prescribe "the library plan," to the exclusion of the other active operations which have been so successfully undertaken.

We find, however, that Mr. Pearce has steadily supported the plan which was finally adopted from the time of its adoption to the present, —a plan which combines the library idea with the scheme of scientific inquiry and investigation.

Mr. Meacham's account, in giving (p. 257) first a summary of Mr. Choate's arguments for the amendments introduced by him into the bill reported by Mr. Tappan, and immediately following this by the statement that "Mr. Pearce also advocated the views of Mr. Choate;" and

by quotations as if from a lengthened speech,—conveys, and seems intended to convey the impression that Mr. Pearce addressed the Senate in support of Mr. Choate's distinctive propositions. Whereas, a reference to the *Congressional Globe* of January 13, 1845, shows that Mr. Pearce's few remarks were made before Mr. Choate's propositions were brought in, and his speech "at great length upon the subject" delivered; and that they were made upon a special question, namely, upon striking out a provision in Mr. Tappan's bill requiring an exclusively scientific library, viz: "that the books to be purchased for said Institution shall consist of works on science and the arts, especially such as relate to the ordinary business of life, and to the various mechanical and other improvements and discoveries which may be made." Moreover, as between Mr. Tappan's general plan, then before the Senate, which provided for the appointment of a staff of salaried professors, and for an institution modeled on the plan of the Imperial *Jardin des Plantes*, menageries and all, to be supported on the small income of Smithson's bequest, and a plan contemplating mainly a library, it is not surprising that a person of such sound practical judgment should have preferred the latter.

Perhaps it is worth noticing, finally, that the several extracts from Mr. Pearce's remarks on this occasion as given in Mr. Meacham's Report (inclusive of three lines, not put under quotation marks) actually comprised his *whole speech*, and indeed more words than the full report in the *Congressional Globe* contains.

2. *Introduction of Bombyx Cynthia into Europe.*—The introduction of this Silkworm into Europe, which is apparently attributed to Prof. Milne Edwards, in the January number last, took place as follows, as we learn from a Periodical published at Calcutta:

"An Italian gentleman, Signor Bergonzi, being desirous of introducing the Palma Christi silkworm into Piedmont, applied through a common friend to Mr. Piddington for a supply of the eggs, which were obtained through Mr. Payter of Bogorah and sent to Professor Baruffi of Turin, but after repeated and varied trials it was found impossible to make the eggs reach Italy in a living state. Sir William Reid having been appointed Governor of Malta, it was thought that the chances of success would be much increased if the insect could be first propagated at Malta, where the Palma Christi is abundant, and where it would also be a great acquisition to the poor but industrious population of that island, in which expensive attempts to introduce the mulberry have wholly failed from the poverty of the soil. That Sir William Reid heartily lent his coöperation we need not say; and after a series of trials and failures too long to relate here, and at the end of *two years* of patient endeavors, a few of the moths, the progenitors of which had been bred in Calcutta by Mr. Piddington, and were actually spinning their cocoons on board the steamer on her passage down the river, in boxes contrived to afford them air and every convenience, laid their eggs, probably in Egypt, and the next generation of worms were born and reared in the Palace of the Knights of St. John of Malta!

"From Malta, eggs have already been sent to Piedmont and to Rome, and we believe to Egypt. Sir William Reid contemplates distributing them, with the aid of the Peninsular and Oriental Company,

who have handsomely given their best assistance to this useful enterprise, on all the shores and islands of the Mediterranean, and he has been furnished, (as well as the Royal Agricultural Society of Turin, which has taken an earnest interest in the project,) with complete directions for the breeding and manufacture of the silk by the gentlemen we have named above; and these will be no doubt translated and circulated so as to enable the poor peasantry of those countries to find considerable resource from a plant which abounds every where about their cottages and fields."

3. *American Association for the Advancement of Science.*—The ninth meeting of the American Association was held at Providence, during the week commencing with August 15th, Dr. JOHN TORREY being the President of the meeting. The next meeting was appointed to be held in August, 1855, at Albany, N. Y., and Prof. JAMES HALL of Albany was elected President for that meeting and the ensuing year.

The contributions to the meeting, in addition to the Address of the retiring President, J. D. DANA, and a Report on the Progress of Organic Chemistry, by Dr. WOLCOTT GIBBS, were as follows:

(1.) *Astronomy and Mathematics.*

On Solutions by Geometrical Construction. By THOMAS HILL, of Waltham, Mass.

New Tables for determining the values of those co-efficients of the Perturbative Functions of Planetary Motion depending upon the ratios of the mean distances. By J. D. RUNKLE, Naut. Alm. Cambridge.

New Tables for converting longitudes and latitudes in A. R's and Decl. By J. D. RUNKLE.

Researches in Analytic Morphology—Transformation of curves. By BENJAMIN PEIRCE, Cambridge.

Solution of Adam's Prize Problem for 1857. By BENJAMIN PEIRCE, Cambridge.

The determination of Longitudes by Occultations of the Pleiades. By BENJAMIN PEIRCE, Cambridge.

Partial Multipliers of Differential Equations. By BENJAMIN PEIRCE, Cambridge.

The Catenary on the vertical right cone. By BENJAMIN PEIRCE, Cambridge.

The motion of a Heavy Body on the circumference of a circle, which rotates uniformly about a vertical axis. By BENJAMIN PEIRCE, Cambridge.

Resistance to the motion of the Pendulum. By BENJAMIN PEIRCE, Cambridge.

Contributions to the Atmospherology of the Sun. By Dr. C. H. F. PETERS, Cambridge.

On the temperature of the Planets, and on some of the conclusions resulting from this temperature. By Prof. ELIAS LOOMIS.

On the mean distance from the Sun, Inclination of Orbit, and Equatorial characters of the Asteroid Planets. By Prof. STEPHEN ALEXANDER.

On the physical phenomena presented during the Solar Eclipse of May 26, 1854. By Prof. STEPHEN ALEXANDER.

On the colored projections from the edge of the sun, as observed during solar eclipses. By Prof. J. HENRY.

Some additions to the new mode of astronomical observations in Right Ascension and in Declination. By Prof. O. M. MITCHEL.

On the Zodiacal Light. By Rev. GEO JONES, Chaplain U. S. N.

(2.) *Physics and Chemistry.*

Notice of earthquake waves on the Western Coast of the United States, on the 23d and 28th of December, 1854. By Prof. A. D. BACHE.

Approximate Cotidal lines of the Pacific Coast of the United States, from observations in the United States Coast Survey. By Prof. A. D. BACHE.

Notice of Tidal Observations made on the coast of the United States in the Gulf of Mexico, with type curves at the several stations, and their decomposition into the curves of diurnal and semi-diurnal tides. By Prof. A. D. BACHE.

Discussion of the secular variation in the Magnetic Declination on the Atlantic and Gulf Coast of the United States, from observations in the 17th, 18th, and 19th Centuries. By CHAS. A. SCHOTT, United States Coast Survey.

A method of producing parabolic fluid mirrors for Reflecting Telescopes. By GEORGE R. PERKINS.

On our sense of the Vertical and Horizontal, and our perception of Distances. By Lieut. E. B. HUNT, U. S. A.

On Binocular Vision. By Prof. W. B. ROGERS.

On the Rotascope or Gyroscope, and the composition of Rotations. By Prof. WM. B. ROGERS.

Improvements in the Electric Telegraph, whereby two or more terminal stations can make simultaneous use of the same wire. By MOSES G. FARMER, of Boston.

Description of a new apparatus for separating Gold and other precious metals from foreign substances. By EDWARD N. KENT.

On a method of analyzing the Sulphate, Arsenate, and Molybdate of Lead. By Prof. J. LAWRENCE SMITH.

(3.) *Geology and Mineralogy.*

On the stratigraphical position of the coal-bearing rocks below the upper Red Shale and Carboniferous Limestone of the Middle and Southern States. By Prof. WILLIAM B. ROGERS.

On the Configuration of the soil of New England. By Prof. A. GUYOT.

On the occurrence of iron ores in the Azoic System. By J. D. WHITNEY, Esq.

On some new localities of minerals. By SANDERSON SMITH.

On some crystallized furnace products. By SANDERSON SMITH.

Contributions to our knowledge of the Geology of Nebraska and the Mauvaises Terres. By Prof. JAMES HALL.

Notes upon the genus Graptolithus. By Prof. JAMES HALL.

On the Development of the Septa in the genus Baculites, from the extreme young to the adult state. By Prof. James Hall.

On the cutting and polishing of Granite and hard materials by drifting sand in the Colorado Desert. By W. P. Blake.

Notice of remarkable specimens of crystallized and arborescent gold, from California. By W. P. Blake.

On the deposits of fossil microscopic organisms at Monterey, California, with specimens; observations on the characters and probable Geological age of the Sandstone formation of San Francisco, California; on the Cinnabar Mine of New Almaden, California. By W. P Blake.

Description of Yellow Creek Coal Basin. By R. P. Stevens.

Sulphuret of Iron formed in Coal since the Drift Era. By R. P. Stevens.

Conclusions from a series of facts respecting the erosions of the Earth's surface, especially by rivers. By Prof. Edward Hitchcock.

Marks of Ancient Glaciers in New England. By Prof. Edward Hitchcock.

Notes on the Geology of Western India. By Rev. E. Burgess.

Remarks on the Geological formation of Table Mountain, Cape of Good Hope. By Rev. E. Burgess.

On the occurrence of Proboscidean remains in Wisconsin. By Edward Daniels.

On the character of the Lead deposits of the Upper Mississippi. By Edward Daniels.

On the occurrence of silicious grits as veinstones in the Lead mines of Wisconsin. By Edward Daniels.

Some observations on the northern outcrop of the Illinois Coal formation. By Edward Daniels.

On minerals of the Wheatley Lead Mine. By Prof. J. Lawrence Smith.

(4.) *Zoology and Botany.*

On gradation among Polypi. By Louis Agassiz.

On the System of Zoology. By Louis Agassiz.

Notes on the nature of the coverings of the seeds of Magnolia, and on the diœcious character of species of Plantago. By Prof. A. Gray.

Motions effected by plants result from the contractions of cells. By Prof. A. Gray.

Notes upon the grove of mammoth trees of Calaveras Co., California; and on a peculiarity of the wood of the red wood (genus Sequoia) of California. By Wm. P. Blake.

(5.) *Meteorology.*

On the Storm of Oct. 7, 1854, near the coast of Japan, and the conformity of its progression with other cyclones. By Wm. C. Redfield.

On the storm which was experienced throughout the United States about the 20th of December, 1836. By Prof. Elias Loomis.

On the Winds. By Capt. Charles Wilkes, U. S. N.

(6.) *Miscellaneous.*

On the frozen wells of Owego, Tioga Co., N. Y. By Prof. JOHN BROCKLESBY.

Notes on the Wilmington Gunpowder Explosion. By Prof. DENISON OLMSTED, of New Haven.

On the effect of mingling radiating substances with combustible materials. By Prof. JOSEPH HENRY.

Account of Experiments on the alleged spontaneous separation of Alchohol and Water, made at the Smithsonian Institution. By Prof. HENRY.

Mode of testing building materials, and an account of the marble used in the extension of the Capitol. By Prof. HENRY.

On an Index of Papers on subjects of Mathematical and Physical Science. By Lieut. E. B. HUNT, U. S. A.

On the use of salt marsh sods for facing the steep slopes of parapets, terraces, &c. By Lieut. E. B. HUNT, U. S. A.

Contributions to the Physiology of Sight. By Dr. T. C. HILGARD.

Laws of reproduction considered, with special reference to the marriage of near blood relations. By Rev. CHARLES BROOKS.

4. *The Climate of San Francisco, for the year* 1854; by H. GIBBONS, M.D.—The year began with very fine weather. On the 5th, was a severe norther which damaged the shipping in the harbor. A few cold mornings followed, and on the 12th the rains set in. From that date to the 24th, rain fell on 9 days, to the depth of 4¼ inches. The rains were cold, and several times accompanied with hail, and snow covered the distant mountains. The coldest weather on my record was at this time. On the 19th, 20th and 21st, the thermometer stood at 31, 25 and 31. At noon on the 20th, it rose no higher than 37. The mud was frozen solid so as to bear the heaviest wagons. Of course, the oldest inhabitant had never seen the like. In December, 1850, it was nearly as cold, the mercury then falling to 27. The month wound up with a few very warm days. The mean temperature at sunrise was 42·26, at 9 A. M. 45·71, at noon 54·23, at 10 P. M. 45·26, being the coldest month on my book—*i. e.* since the winter of 1849–50. The greatest heat was 69, and the extreme of cold 25. The prevailing winds were N, NE, and NW.

It should be mentioned, as a rare phenomenon, that hail fell on the morning of the 15th, so as to cover the ground and it lay for an hour. In the winter of '49–50 the ground was covered with hail or snow in like manner.

February was rather warm. The mean at sunrise was 47·93, at 9 A. M. 50·86, at noon 59·21, and at 10 P. M. 49·07. The extreme of heat was 69, of cold 38. Rain fell on no less than 13 days, and in the quantity of 8·41 inches—the greatest quantity in any month on my record, excepting Dec. 1852, when there was nearly 12 inches. This is the more remarkable as February is usually a dry month. On the 12th hail fell in a heavy shower so copiously that it could be gathered by the bucket full where it collected from the roofs. The prevailing winds were from W, S, NW and N, in the order named as to frequency. Our high wind occurred from SSE.

March was of moderate temperature. The mean at sunrise was 47·23, at 9 A. M. 52·06, at noon 60·97, at 10 P. M. 49·45. The extreme of heat was 72, of cold 38. Rain fell on 10 days 3·17 inches, a moderate supply for March. Most of the rain was during a cold storm on the 13th, 14th and 15th, the wind blowing moderately part of the time from Northeast, which is a rare direction for a rain-wind. The Westerly winds increased in frequency, as usual in this month. Those from S, NW and N, divided among them one-half the month. There were no high winds.

The warmest April on my book was that of 1854. The mean at sunrise was 51·10, 9 A. M. 59·83, noon, 68·43, 10 P. M. 52·90. The extreme of heat was 83, of cold 45. Rain on 6 days, 3·31 inches, nearly two inches of which fell on the 28th,—the last rain of the season. The sea-breeze came nearly every day, though with moderate force. On 10 days the winds were from other quarters than West. During this month the hills and fields assumed the gorgeous array of flowers which marks a California landscape in the spring.

May was a very unpleasant month, cold and windy, often cloudy and threatening rain. On one day only there was rain, and then but two-hundredths of an inch, in the form of mist. The mean temperature at sunrise was 48·95, at 9 A. M. 59·00, at noon 64·61, at 10 P. M. 50·68 —being three degrees below April. The mercury rose no higher than 73, and the lowest extreme was 43. There were light frosts on several mornings, and vegetation advanced tardily. Potatoes of the season's growth appeared in market on the 1st. A hail storm occurred at Sacramento on the 6th. The winds were westerly on 25 days. On 8 days they were high.

June, also, was a cold month, rather below April in temperature. Mean at sunrise 50·10, 9 A. M. 61·83, noon, 66·80, 10 P. M. 51·50. The warmest day was 74, and the coldest morning 47. There was an unusual tendency to rain, and several times a few large drops deigned to violate the law of the season. On the 17th it rained moderately for two hours, four-tenths of an inch collecting in the gauge. On the 13th was a heavy storm of rain and hail in Utah. On 23 days the wind was West, and on four NW. It was high on eight days.

July was rather above the average temperature. The means were, at sunrise 51·87, 9 A. M. 63·94, noon 70·65, 10 A. M. 54·16. In the three years preceding, the mercury had not reached 80 in July, but in this year it was at or above 80 on four days, and on one day as high as 87, which is near the extreme heat of our climate. The lowest extreme was 46. The first week was beautifully clear, but afterwards there was scarcely a morning or evening without cloud and mist. The wind was constantly West, and on six days it was high.

August was a trifle below the average temperature. Mean at sunrise 52·42, 9 A. M. 62·39, noon 68·29, 10 P. M. 53·81. There were two days above 80, the highest being 85. The minimum temperature was 50. Almost every afternoon was windy, and though the wind was high on one day only, yet the weather was about as unpleasant as our summer climate can afford. The mornings were generally cloudy and the evenings misty. A light shower of rain fell on the 27th. At Los Angeles and San Diego it rained heavily on the 20th and 21st, and on the

Trinity river there was a thunder storm on the 26th, with heavy rain and snow on the mountain peaks.

September, commonly the warmest month in the year, was nearly as cold as August. Mean at sunrise 53·30, 9 A. M. 61·43, noon 67·73, 10 P. M. 54·40. There were two warm days, on one of which the mercury rose to 87. The greatest depression was 46. Cloudy mornings and misty evenings prevailed, and the sea breeze blew with great constancy and with more force than usual in September. This month seldom passes without rain, but on the present occasion the only rain was a trifling shower on the 15th. There was a heavy rain at Los Angeles about the same time.

The weather of October was generally agreeable. Mean temperature at sunrise 53·32, 9 A. M. 60·97, noon 68·13, 10 P. M. 55·42. There were three days above 80, the warmest being 83. The minimum temperature was 46. It was the warmest month of the year except July. The winds were light, and distributed to W, NW, N, and S, the first predominating. The most extraordinary feature of the month was its frequent rains. Rain fell on no less than 10 days, quantity 2·12 inches. The first rain was on the 4th. At Marysville the ground was covered with hail on the 23d. At the close of the month the hills around the city began to look green, and the wise men predicted a very rainy winter.

The climate of November was fine. Mean at sunrise 50·67, 9 A. M. 55·97, noon 65·13, 10 P. M. 53·00. The extremes were 72 and 47. The mornings ranged from 47 to 55, and the noondays from 58 to 72. The winds were from W, NW and N, and gentle as zephyrs. The sky was most uninterruptedly clear. A single rain fell, amounting to four-tenths of an inch, and the wise men reversed their prediction and promised a very dry winter instead of a wet one.

December furnished a continuation of the fine weather of November, with a decline of temperature corresponding to the season. Mean at sunrise 47·03, 9 A. M. 51·32, noon 60·65, 10 P. M. 49·39. There were a number of slight frosts, and ice formed in favorable situations, though the minimum temperaure was 38. The warmest day was 71. The most gentle breezes prevailed from North, Northeast and Northwest. There were 15 days entirely clear. A trifling rain, ·08 inches, fell on the 3d, and no more until the 31st, when a rain storm set in which was quickly handed over to the new year, leaving three-tenths of an inch to December.

The mean temperature of the whole year sums up as follows: Sunrise 49·68; 9 A. M., 57·11; noon, 64·57; 10 P. M., 51·76. The mean of the sunrise and noon observations gives as the figure for the year, 57·13. The temperature for 1851, deduced in the same way, was 56·57; 1852, 56·53; and 1853, 58·51. The year 1853 appears to have been unusually warm. Taking 1854 as a fair representation of the climate of San Francisco, it follows that our climate is two or three degrees warmer than that of the corresponding latitude on the Atlantic coast, though it exhibits neither the extremes of heat or cold incident to the latter.

The extreme of heat in 1854 was 87. There were only twelve days in the year at or above 80, of which one was in April, 4 in July, 2 in

August, 2 in September, and 3 in October. In 1851 there were 9 days at or above 80; in 1852, 13; and in 1853, 11.

The extreme of cold was 25. There were three days in the year when the mercury fell to the freezing point, all in January. In 1851 the thermometer fell to the freezing point on one day only. In 1852, 35 was the lowest depression; and in 1853, it did not sink below 40.

The warmest month in the year was July, then October, then September, then August, then April, and June stands the sixth in order, and only two degrees above November. In neither of the three years preceding, was July the warmest month. In 1851 the warmest months occurred in the following order: August, October, September, June, July, April. In 1852, September, July, August, June, October, November. In 1853, October, September, June, May, July, August. To the daily visitations of the cold ocean wind in the summer is owing this great variation from the order of the months as to comparative temperature in other climates.

January was the coldest month, then February, then December and next March. In other years December sometimes takes the precedence of January. February, which in the Atlantic States is often the coldest month in the year, is not so here.

Rain fell on 54 days in the year, 22·12 inches in depth. This is our average supply, though only half the quantity that falls in the Atlantic States. In 1853, the quantity was 19·03 inches; in 1852, 25·60 inches; and in 1851, only 15·12 inches. The old inhabitants tell of occasional seasons when scarcely any rain has fallen, and when the cattle have perished from want. Such very dry seasons are said to recur at intervals of 8 or 10 years.

The greatest amount of rain was in February—next comes January, next April, then March. This differs from the ordinary arrangement. Taking the last four years into view, December gives the most rain, and March comes next, while the intervening months are comparatively dry. In fact we have the early rains, beginning in November and continuing through December into the early part of January, and the later rains, beginning in March, and continuing at times through April.

Lightning is seen at San Francisco on an average three or four times a year, and thunder is less frequent. On the 15th January, flashes of lightning were observed in the evening during a cold rain storm from South; and on the 22d February, under similar circumstances lightning was again noticed. But no thunder was audible in either case; nor was there any further exhibition of atmospheric electricity during the year. There was thunder three times in 1851, five times in 1852, and twice in 1853.

No exhibition of Auroral light was observed in the year. Since my residence here, from Aug. 1850, I have seen the Aurora Borealis only on two occasions, once in January and once in February, in the year 1852.

Earthquake shocks were distinctly felt on the mornings of the 9th of January and 21st of October.

5. *Iron ore of Dodge and Washington Cos., Wisconsin.*—Dr. Percival, in a report on this ore, states that it occurs in a bed 7 to 15 feet thick, lying between two strata of limestone, "that below obviously cor-

responding in its physical characters and fossils to the upper shell bed of the Blue limestone of the mineral district, and that above to the upper magnesian limestone. The iron is argillaceous and mainly is lenticular ore (called also seed or shot ore). The iron ore layer has a slaty structure. It is usually overlaid by a thin layer of a very dark blueish and hard compact ore, breaking with a conchoidal fracture. The bed is one of great value, and of inexhaustible extent, and occurs in a densely timbered country.—*Rep. by Dr. J. G. Percival, dated Milwaukee*, 1855.

6. *Clouds.*—Photography has been used successfully in Paris in taking views of clouds. They have been obtained by Bertsch in hardly a quarter of a second in a style which leaves nothing to be desired. They are adapted to resolve, as M. Pouillet states, all the important questions relating to their form, distribution and height. M. Pouillet measures the height by means of two photographic apparatuses, placed at a distance from one another.—*L'Institut*, No. 1118, June, 1855.

7. *Pottsville Scientific Association.*—The first Bulletin of this Society, for January and February of the current year has been issued, in a pamphlet of 14 pp., 8vo. It contains a translation by Mr. I. O. Meredith of a paper by Mr. Desor on the Falls of Niagara.

8. Obituary.—*Notice of the late John Graem Ellery.*—By the death of John G. Ellery, science has lost one of its most energetic and indefatigable workers, who could ill be spared from his favorite field of investigation.

He died on the 2nd of June, 1855, at Gold Hill, Rowan Co., N. C., of one of those virulent attacks incident to the climate. He had been engaged there for some months in a Geological Survey, having direct reference to the value and most economical mode of working the gold, silver, and copper ore of that region, and was just about to return to New York, when he was prostrated by sickness.

Mr. Ellery was educated in part at Hamilton College, N. Y., and afterwards graduated at Amherst College, Mass. Having chosen the department of geology and mineralogy as the great study of his life, he turned his attention after leaving college, to the study of chemistry, as the groundwork of his preparation, for the special object of his pursuit. His studies were completed at the Royal Academy of Mines, in Freiberg, Saxony, where in an unusually short time, he not only familiarized himself with the principles of mineralogy and geology, but also mastered the practical departments of Mining and Metallurgy. He was well versed in the department of analytical chemistry, and under Plattner became especially proficient in the use of the blowpipe. It was his ambition to fit himself for developing the mineral resources of his own country, and to this end his efforts were unwearied. His devotion to science as well as his true manliness of character, won for him there as well as here, the highest respect and confidence of his teachers. His career since his return from Europe, though brief, had been full of promise. He had already accumulated a fund of information with regard to the mineral resources of North Carolina that would soon have been made available to the public, had he not fallen thus prematurely. All who knew him merely as a man of science, feel most deeply the loss to themselves and to the world: but besides these, a wide circle of

friends, who appreciated not only his scientific qualifications, but his many excellencies of character, his integrity of purpose, his native kindness of heart, his self-sacrificing spirit, feel more deeply than words can express the affliction that has come upon them.

New York, June 9, 1855. A. K. E.

Mr. Thomas Weaver.—The veteran Geologist, Mr. Thomas Weaver, died at his residence in Stafford place, Pimlico, on the 2nd inst., in the eighty-second year of his age. The contemporary of Humboldt and Leopold von Buch, he acquired, in company with these illustrious men, his rudiments of mineralogy and geology under the tuition of Werner, at Freiberg, having been entered on the books of that celebrated Mining Academy in 1790. Among his numerous memoirs published in the "Transactions of the Geological Society," those upon "The East and South of Ireland" are perhaps the most praise-worthy, for the service they rendered to the development of the mineral structure of that country. Mr. Weaver was, until within these few years, a frequent contributor to the Philosophical Magazine and other scientific periodicals. Amid the geologists of this country, no one was more distinguished for a kind and friendly disposition, which endeared him to all his associates.—*Athen.*, *July* 7, 1855.

Andrew Crosse.—Mr. Andrew Crosse, the enthusiastic and somewhat eccentric amateur of science—whose experiments in electricity and his fancied creation of insects some years ago made a stir among the credulous and incredulous—died the other day at his residence near Bridgewater, having passed the threescore years and ten allotted to man.—*Athen.*, *July* 21, 1855.

9. *Report of Exploration of a Route for the Pacific Railroad*, near the 47th and 49th Parallels, from St. Paul to Puget Sound; by J. J. Stevens, Governor of Washington Territory. H. Doc., 129.—Governor Stevens's Report extends to 600 pages 8vo, and embodies details of his own observations relating to regions hitherto little explored, and also various accompanying reports occupying 500 pages of the volume.

In the Report of Mr. George Gibbs, it is stated that Mount Baker, near Puget's Sound is said to have been in slight eruption during the winter of 1853–'54, throwing out light clouds of smoke. The last eruption preceding was in 1843 when a slight shock of an earthquake was felt at Port Langley. He observes also that St. Helens was smoking; adding,

"This [St. Helens] and Mount Baker are the only volcanoes at present active in the chain. Its last considerable eruption was in 1842, when it covered the country as far as Vancouver and the Dalles with ashes, and presented a luminous appearance after the smoke had cleared off. The Indians report that there were once three mountains that smoked always, Mount Hood and Mount Adams being the others. Respecting Mount Hood and Mount Adams, they have a characteristic tale to the effect that they were man and wife; that they finally quarrelled and threw fire at one another, and that St. Helens was the victor; since when Mount Hood has been afraid, while St. Helens having a stout

heart, still burns. In some versions this story is connected with the slide which formed the Cascades of the Columbia, and by damming up the water inundated the forest, the remains of which are now visible along its margin. The date of this event Lewis and Clark fixed at about thirty years before their arrival. It is very probable that it may have been due to an earthquake, as earthquakes, though not frequent, are known upon the coast. The Indians have no tradition of an eruption of lava; they have only seen smoke and ashes come out of the mountain. They add that a bad smell came from it, and that the fish in the streams died. Around the foot of St. Helens, they say, the ashes are so deep and soft that horses cannot travel."

Mr. Gibbs gives the following account of the Coal of Bellingham Bay:

"I visited the coal-beds on the D'Wamish and at Bellingham Bay, but I had no time for making more than a very superficial examination. That on the outlet of D'Wamish lake is situated immediately upon the water, a few rods below Tobin & Co.'s mills, and about a mile from the lake. The outcrop is exposed to the eastward or river side, and dips to the water at an angle of about 15°, being broken off towards the north by a fault. The total depth of the bed, including shale, is 13 feet, with 6½ feet of workable coal, divided by a thin seam of fire-clay. The drift had been carried in only about 75 feet. The coal appears to be of good quality, and to burn well with a strong flame, leaving no slag. It is considerably laminated, and has a tolerably bright fracture. The indications are said to continue westward for a considerable distance. Another bed has been discovered lower down, on the main D'Wamish, at Stevenson's claim. It is intended to transport this coal in scows to the town of Seattle, about sixteen miles distant by water.

"Two beds had been opened at Bellingham bay, and the coal was visible in the immediate bank for a long distance. The beds are from 2 to 16 feet thick, and dip to the north at angles ranging from 19 to 37 degrees. The overlying rock is a light-colored yellowish sandstone, containing pebbles and concretions of clay. No associated fossils were seen. The shales are very thin as far as noticed, and limestones entirely wanting. Some of the outcrops of coal appear to be at the edge of faults, but the thickness of the formation itself was not examined. The seam which had been most worked—that known as the Ma-moosie mine—was altogether eight feet through, but divided by three feet of clay and slate, leaving only an equal amount of workable coal. A drift had been carried in about 175 feet, the quality improving somewhat. The superior seams at this place did not appear to be worth working. About 150 tons only had been got out, which was mostly on board a vessel bound to San Francisco.

"Another bed, a little to the north of this, belonging to Captain Fauntleroy and others, presented much better indications. Its thickness is sixteen feet four inches, and the coal brighter and freer from impurities than the other. A small quantity got out here sold in San Francisco for $23 per ton. A bed of nearly equal depth is said also to have been since found in the southern part of the Bay. Other beds have

been found on Samish bay, and Mr. H. A. Goldsborough saw it upon the Stoluckwamish in workable seams, but not accessible to water transportation. The coal at Bellingham bay, must be lightered on board of vessels, the water being shallow to a considerable distance from the shore.

"The whole of this formation has been considered by geologists as tertiary, and the coal as not belonging to the true coal. Be this as it may, its value for economical purposes is unquestionable. Even that on the Cowlitz and Skookum, though inferior to the product of the D'Wamish and Bellingham bay mines, was abandoned only from its not being accessible to tide-water."

10. *Report of Exploration of a Route for the Pacific Railroad*, near the 38th and 39th Parallels of Latitude from the mouth of the Kansas to Sevier River in the Great Basin; by Lieut. E. G. BECKWITH, Third Artillery. Also Report, by the same, of Explorations on the line of the 41st Parallel of North Latitude, 1854.—Both reports contain much important information concerning the geography and productions of the routes traversed.

11. *Report of a Reconnoissance and Survey in California*, in connection with Explorations for a Practicable Railway route from the Mississippi river to the Pacific Ocean, in 1853; by Lieut. R. S. WILLIAMSON, U. S. A., Corps of Topographical Engineers. 80 pp., 8vo.—Lieut. Williamson's Report includes the Geological Report of W. P. Blake, noticed in the preceding volume of this Journal, p. 433.

12. *Report of Exploration of a Route for the Pacific Railroad*, near the 32d parallel of latitude from the Red River to the Rio Grande; by Brevet Captain JOHN POPE, Corps of Topographical Engineers. H. Doc., 129.—Besides the general account of the country traversed, the volume contains a short Geological Report by JULES MARCOU, and a Catalogue of the Plants, by Dr. JOHN TORREY, with descriptions of a few new species. The evidence of Jurassic rocks on the Rocky mountains which Mr. Marcou presents is wholly unsatisfactory. Cretaceous beds were found as far as the "upper cross Timbers" in longitude 97° 30′ and latitude 33° 40′.

13. *Report of Explorations for a Railway Route* near the 35th Parallel of Latitude from the Mississippi river to the Pacific Ocean; by Lieut. A. W. WHIPPLE, Corps of Topographical Engineers. H. Doc., 129.—The general description of the route and country is followed by a Geological chapter by Jules Marcou; another on Economical Zoology, by C. B. R. KENNERLY, and on the Soil, Productions and Special forest trees, by J. M. BIGELOW, Botanist, besides tables of heights and distances, and another of Meteorological observations.

14. *Report of Explorations for that portion of a Railway Route* near the 32nd Parallel of latitude lying between Dona Ana on the Rio Grande and Pimas Villages on the Gila; by Lieut. JNO. G. PARKE, U. S. A., Corps Topog. Engineers. H. Doc., 129.—Lieut. Parke visited Tuczon and saw the famous meteorites there which have been described in this Journal by Prof. Shepard and Dr. J. Lawrence Smith. The Report contains information on the region passed over with a table of calculated Barometrical heights.

15. *An Examination, by direction of the Hon. Jefferson Davis, Secretary of War, on the Reports of Explorations for Railroad Routes from the Mississippi River to the Pacific*, made under the Orders of the War Department in 1853–'54, and of the Explorations made previous to that time, which have a bearing upon the subject; by Capt. A. A. HUMPHREYS and Lieut. G. K. WARREN, Corps Topog. Eng., Washington, 1855. H. Doc., 129.—A valuable review of the Facts collected in different Explorations of the Rocky mountains, with reference to the Pacific Railroad route.—Also a Report of the SECRETARY OF WAR on the several Pacific Railroad Explorations.

16. *An Introduction to Practical Astronomy, with a collection of Astronomical Tables;* by Prof. ELIAS LOOMIS, LL.D., &c.—Every cultivator of practical astronomy must have felt the want of some treatise embracing within moderate compass the requisite formulæ and tables, together with descriptions of the most approved instruments and methods of observation. The only work in English to which he could refer—Pearson's—besides being bulky and very expensive, is out of date.

This want it has been the aim of Prof. Loomis to supply. Amateur observers, surveyors, scientific travelers, and students of practical astronomy generally, will welcome the present work as one especially adapted to their necessities.

The chapters on instruments are clear, comprehensive and practical. Demonstrations accompany the mathematical formulæ, so that the student has, at every step, the means of satisfying himself of the accuracy of the methods adopted. This characteristic of the work will give it especial value as a college text-book. The accurate computation of eclipses and occultations, and the determination of longitudes from observations of these phenomena, have received particular attention. In no other English treatise, so far as we are aware, are Bessel's formulæ so well developed and applied.

A marked feature of the work is the catalogue of 1500 stars, embracing all above the sixth magnitude, and giving their positions with all the accuracy of the most approved standard catalogues. This feature will be especially valued by those who are unable to purchase the expensive British Association and Twelve Year Catalogues, from which this has chiefly been taken, or who desire, in a more portable form, a catalogue of such stars as come within the range of ordinary instruments. The constants for computing the apparent places are also given. Great care seems to have been taken to render not only this catalogue, but the other tables, and the work generally, as reliable as possible. The author's known habits of discrimination and scrupulous accuracy are a sufficient guaranty that in this particular the book will be found unusually free from fault.

The work being intended only as an introduction, and containing less than 500 pages, no one will expect it to treat of the higher and more intricate branches of practical astronomy, such as the computation of orbits, perturbations, etc. But to the classes for whom it was prepared it can safely be recommended, as having, for their purposes, no superior in the English language, if, indeed, in any other.

17. *The Relations of Chemistry to Agriculture, and the Agricultural Experiments of Mr. J. B. Lawes;* by JUSTUS VON LIEBIG. Translated by SAMUEL W. JOHNSON, at the author's request. 88 pp., 12mo. Albany, N. Y., 1855.—This little work is a translation of a recent agricultural treatise by Prof. Liebig, by one who has the full confidence of its author, both in his knowledge of agricultural chemistry and of the language in which it is written. Mr. Johnson has resided at Munich for the past year and a half, where, while pursuing his studies, he has had constant intercourse with the eminent Professor of that University.

18. *A Treatise on Pneumatics*, being the Physics of Gases, including vapors: containing a full description of the different Air Pumps, and the experiments which may be performed with them; also the different Barometers, Pressure Gauges, Hygrometers, and other Meteorological Instruments, explaining the Principles on which they act, and the modes of using them. Illustrated by numerous wood engravings, by MARTIN H. BOYE, M.D., A.M., Prof. Nat. Phil. & Chem., &c. 116 pp. 8vo, with several tables. Philadelphia, 1855. E. C. &. I. Biddle.—This treatise, by one of the best chemists of Philadelphia, is written with precision and clearness, and will be found a valuable and convenient work. It is well illustrated with cuts, and contains tables for Barometric and Hygrometric calculations, including tables for the tensions of vapor of water, calculated from those of Regnault, being reduced to English measures and the Fahrenheit scale.

19. *Fossil Footmarks in the Red Sandstone of Pottsville, Pennsylvania;* by ISAAC LEA, LL.D., Vice President of the Acad. Nat. Sci., Philadelphia, &c. 16 pp. super-royal folio, with one double lithographic plate. —The fossil footmarks found by Dr. Lea in the vicinity of Pottsville, and described and figured by him in the Proceedings of the American Philosophical Society for June, 1849, and thence cited in this Journal, are here figured anew of natural size, on a plate of magnificent dimensions as well as beauty of finish. The slab itself measures three feet in length by two in breadth, and contains six tracks in a double row, the tracks duplicated by the hind foot falling into the impression of the forefoot, but a little more in advance. As these tracks have already been described in this Journal, we will not enter into details at this time. Dr. Lea argues that the rock is Devonian. It is No. XI. of Prof. Rogers, a formation generally regarded as above the Catskill group, and constituting the lowest portion of the beds of the carboniferous age, probably synchronous, with some part of the carboniferous limestone.

The typography of this work is beautiful beyond any thing hitherto published in this country, well comporting with the majestic size of the page.

20. *Fossils of South Carolina;* by M. TUOMEY and F. S. HOLMES. Charleston, S. C., 1855. John Russell.—The appearance of the first number of this beautiful work was announced in a former volume of this Journal. Nos. 2, 3, 4, 5, 6, sustain the same elegant style of typography and plates. Each species described is figured, and the lithographs are remarkably fine in drawing and engraving. These numbers contain many species of Molluscs, Echinoderms and Corals. We com-

mend the work for its beauty as well as its science, and would urge all to subscribe for it, who wish it completed.

21. *The Natural History of Man:* comprising Inquiries into the Modifying Influence of Physical and Moral Agencies on the different Tribes of the Human Family; by JAMES COWLES PRICHARD, M.D., F.R.S., M.R.I.A., &c.: 4th edition, edited and enlarged by EDWIN NORRIS, of the Royal Asiatic Society of Great Britain and Ireland. Illustrated with 62 colored plates, engraved on steel, and 100 engravings on wood. In two volumes, of 720 pages, 8vo. 1855. London, H. Baillière.—The great value and interest of Prichard's "Natural History of Man" has long been acknowledged. It is the only work in our language that takes up this subject in so extended and thorough a manner, and the whole is presented in a style at the same time popular and judicious. The present edition is issued on fine paper, with a large number of the 60 steel plates of faces colored. Many additions have been made to the volumes by the editor, Mr. E. Norris, without any mutilations of the original work, or any modifications beyond what was required by the new information added.

22. *Quekett's Practical Treatise on the use of the Microscope*, 3d edition, forming vol. vi, of the "Library of Illustrated Standard Scientific Works," 556 pp., 8vo, with 10 plates and many woodcuts. London, 1855. H. Baillière.—This edition of Quekett's Treatise on the Microscope, a work already familiar to our readers, has just been issued in superior style by H. Baillière.

23. *Human Longevity and the amount of life upon the Globe;* by P. FLOURENS, perpetual Sec'y. to the Academy of Sciences, Paris, &c., &c. Second edition, translated from the French by CHARLES MARTEL. 198 pp., 12mo, 1855. London: H. Baillière.—We have derived from this book both amusement and instruction. The author extols the happy calmness of old age, and argues from physiology, hygiene and analogy that the natural period of man's life is one hundred years, and that if his life is cut short before that term he is killed—he does not *die* before the full century. Taking into view the fact that the perfect union of the bones with the epiphyses takes place in man at 20 years, and regarding this anatomical sign as a proof of complete development—as the close of the period of youth—and further assuming the period of growth as one-fifth of the whole duration of life, he arrives at one hundred years as the full term of life for man. He observes, by way of analogy, that—

In the Camel this union takes place at	8	years;	period of life	40 years.
Horse,	5	"	"	25
Ox,	4	"	"	20
Lion,	4	"	"	20
Dog,	2	"	"	10
Cat,	18	mon.	"	9 to 10
Rabbit,	12	"	"	8
Guinea Pig,	7	"	"	6–7

The book will repay a careful perusal.

24. *Annals of the Astronomical Observatory of Harvard College*, vol. i, Part II, 1852–1853. Printed from funds resulting from the will of

Josiah Quincey, Jr., who died in April, 1775, leaving a name inseparably connected with the history of the American Revolution. 316 pp., 8vo. Cambridge, 1855.—This volume contains the results of Astronomical Observations made at the Harvard Observatory under the direction of WILLIAM CRANCH BOND, A.M., Fellow of the American Academy of Arts and Sciences, &c., GEORGE P. BOND, A.M., 1st Assistant, CHARLES W. TUTTLE, A.M., 2nd Assistant. It includes a Zone Catalogue of 5500 Stars, between the equator and 0° 20′ N. Declination, observed during the years 1852–53. The tables contain the right ascension and declination of all stars in the zone mentioned to the eleventh magnitude, with as many of the twelfth as could be conveniently added without interfering with the other observations. The methods of observation and reduction, and the instruments, being in many respects new, full descriptions are given as introductory to the Tables.

25. *Chemical Examination of the Baker's Bread of Philadelphia;* by C. M. WETHERILL, Ph.D., M.D.—Dr. Wetherill observes after 24 analyses, that although he found that adulterations were employed in a very few instances, the bread is generally quite pure. Alum was detected in two samples and copper in one. Salæratus was found to be in very common use among the bakers.

26. *Report of the Commissioner of Patents* (CHARLES MASON, Esq.), *for* 1854: *Arts and Manufactures.* 776 pp., 8vo, with a separate volume of plates in 332 pages 8vo. Washington, 1855.—The Report of the Commissioner of Patents, always an important document, is not now confined merely to descriptions of the various patents issued; the illustrations, constituting a second volume, are exceedingly numerous, and although woodcuts, appear to have been made with care. Each of the 332 pages is filled with neat figures embracing views of machinery, implements of various kinds, etc., etc.,

27. *Report to the Secretary of the Smithsonian Institution on the Fishes of the New Jersey Coast,* as observed in the Summer of 1854; by SPENCER F. BAIRD, Assist. Secretary S. I. From the ninth Annual Report of the Smithsonian Institution for 1854, 40 pp., 8vo. Washington, 1855.—This valuable Report embraces various notes on the localities habits and characters of the species of fish, 67 in all, observed by Dr. Baird on the Coasts of New Jersey and Long Island.

28. *A Geological Map of Wisconsin;* by J. A. LAPHAM, of Milwaukie, Wisconsin.—This colored map, measuring 11 inches by 14, indicates in colors the outlines of the principal rock strata of the state of Wisconsin, mentioning the rocks by their western names and without indicating their eastern equivalents.

29. *Proceedings of the American Association for the Advancement of Science,* 8th Meeting, held at Washington, D. C., May 1854, 316 pp. 8vo.—To be had of Prof. J. Lovering, Cambridge, Mass., Permanent Secretary of the Association, or J. P. Putnam & Co., New York City.

EIGHTH ANNUAL REPORT of the Regents of the University of the State of New York, on the Condition of the State Cabinet of Natural History and of the Historical and Antiquarian Collection annexed thereto. Made to the N. Y. Senate, Jan. 15, 1855. 70 pp., 8vo. Albany, 1855.

SIXTY-EIGHTH ANNUAL REPORT of the Regents of the University of the State of New York. Made to the Legislature, March 1, 1855. 350 pp., 8vo. Albany, 1855. —The Appendix contains considerable meteorological information.

JOHN PHILLIPS: A Manual of Geology, Practical and Theoretical, with a geological map of Great Britain and numerous illustrations of fossils, scenery, &c. Crown 8vo. London and Glasgow: Richard Griffin & Co. 12*s* 6*d*.

Dr. LINDLEY: Ferns of Great Britain; in splendid folio, represented of life size and colored by nature-printing.—Parts I. to IV. have been issued. 6*s*. each. London: Bradbury & Evans, 11, Bouverie street.

T. C. SIMON: Scientific certainties of Planetary life, or Neptune's light as great as ours, &c. Fcap. 8vo. 1855. London: T. Bosworth.

Dr. LARDNER: Museum of Science and Art. Vols. I. to VI. completed; continued weekly. London: Walton & Maberly.

M. FARADAY: Experimental Researches in Electricity, Vol. III. 1855. London: Taylor & Francis.

WM. CLARK: A History of the British Marine Testaceous Molluscs. 8vo. 1855. London: J. Van Voorst. 15*s*.

Mrs. LOUDON, assisted by George Don, F.L.S., and David Wooster, late curator of the Ipswich Museum: New edition of Loudon's Encyclopedia of Plants. 1 Vol. 8vo., with above 12,000 wood-cuts. 1855. London: Longman, Brown, Green & Longmans. £3 13*s*. 6*d*.

RANSOME'S IPSWICH MUSEUM: Portrait Gallery of Celebrated Scientific Men. 60 Lithographic Portraits, 22 inches by 15. London: S. Highley. 7*s*. each, or the complete series in Portfolio, £14.

ENTOMOLOGIST'S ANNUAL for 1855. London: J. Van Voorst. 2*s* 6*d*.

CHARLES JOHNSON, Esq.: The Ferns of Great Britain, illustrated by John E. Sowerby. 1 Vol. 49 pl. London: J. E. Sowerby. 27*s*. colored; 14*s*. partly colored.

JONATHAN PEREIRA: Lectures on Polarized Light: 2nd. edit., greatly enlarged by the Rev. Baden Powell. Fcap. 8vo., with woodcuts. London: Longman, Brown, Green & Longmans. £3 13*s*. 6*d*.

Dr. H. SCHACHT: Das Mikroscop und seine Anwendung insbesondere für Pflanzen-Anatomie. 2nd edit. 206 pp., 8vo, with 5 plates. Berlin.

EDWARDS & HAIME: Monographie des Polypiers Fossiles des Terrains Paleoziques. 4to, with numerous plates. Paris.

JUNGHUHN: Fossiles de Java. Part IV (Echinodermes). Leyden: 1854.

PICTET: Materiaux pour la Paleontologie Suisse, &c. 4to, with plates.

Sur les Tempêtes Electriques et la quantité de Victimes que la foudre fait annuellement aux États-Unis d'Amerique et a l'Ile de Cuba, par ANDRES POEY (de la Havane). 15 pp., large 8vo. Versailles, 1855.

Tableau Chronologique des Tremblements de Terre ressentis a l'Ile de Cuba de 1550 à 1855; par M. ANDRE POEY. (Extr. des Nouvelles Annales des Voyages, June 1855). 26 pp. 8vo.

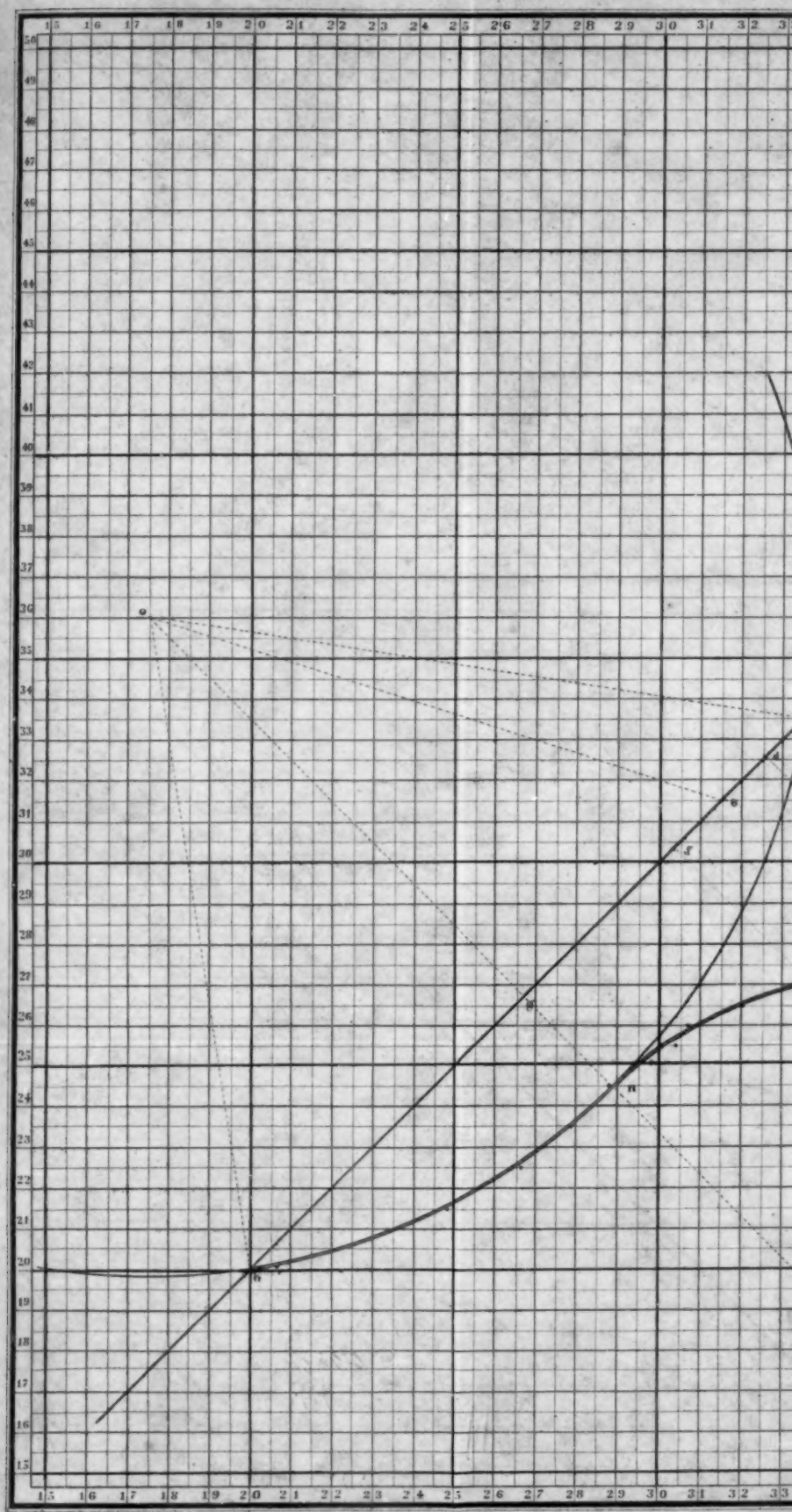
Mémoire sur la fréquence des Chutes de Grèles à l'Ile de Cuba, des cas qui eurent lieu de 1784 à 1854, et des temperatures minima de la Glace et de la Gelée blanche observées dans cette ile; par M. André Poey. 20 pp., 8vo., Paris, 1855.

THE QUARTERLY JOURNAL OF THE GEOLOGICAL SOCIETY, Vol. X, Part 2, May 1, 1855.

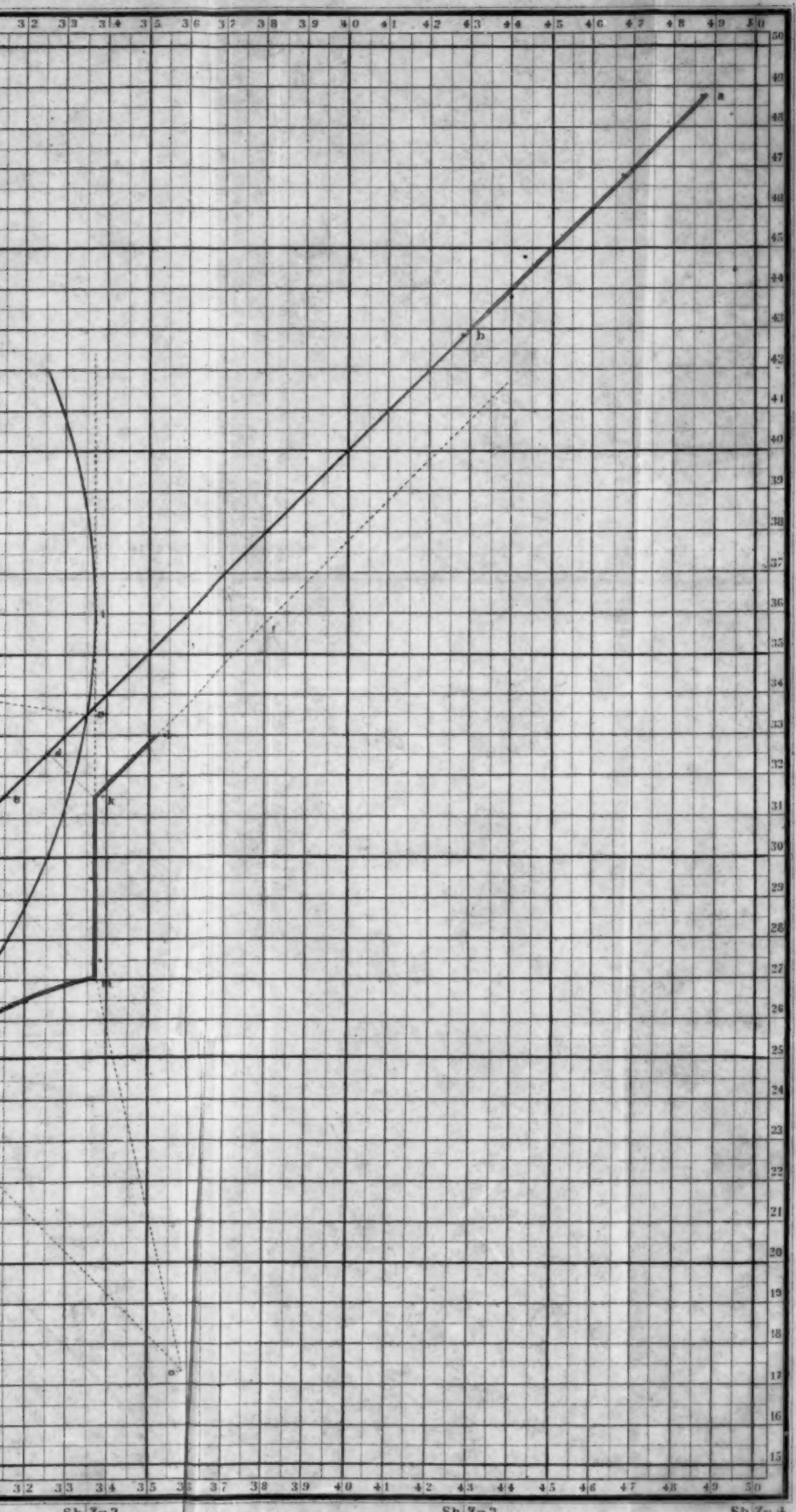
PROCEEDINGS BOSTON SOC. NAT. HIST. Vol. V, p. 200.—The following officers were elected in July for the ensuing year. JOHN C. WARREN, M.D., President; C. T. JACKSON, M.D., and D. HUMPHREYS STORER, M.D., Vice-Presidents, S. L. ABBOTT, M.D., Corresponding Secretary, etc.—p. 201, On a new locality of the so-called *Posidonomya* of the Mesozoic rocks, in Virginia; and on the effect of Trappean rocks on the same beds; *W. B. Rogers*.

PROCEEDINGS OF THE ACAD. NAT. SCI., PHILADELPHIA, Vol. VII, No. ix.—p. 340, Description of a new Mollusc from the Red Sandstone near Pottsville, Pa., (Cypricardia Leidyi), with a plate; *Isaac Lea*.—p. 342, Habits of the Moose; *C. J. Gilman*.—p. 346, Notes on the Amaræ of the U. States; *J. L. LeConte*.—p. 356, Synopsis of the Hydrophilidæ of the U. States; *J. L. LeConte*.—p. 375, Descriptions of some of the new Marine Invertebrata from the Chinese and Japanese seas; *W. Stimpson*.

CURVE EXHIBITING THE VARIATION IN COMPOSITION OF THE



F THE CRYSTALS FORMED IN THE ALLOYS OF ZINC AND ANTIMONY.



Sb Zn2 Sb Zn3. Sb Zn4.

ad by Analysis in the Crystals.